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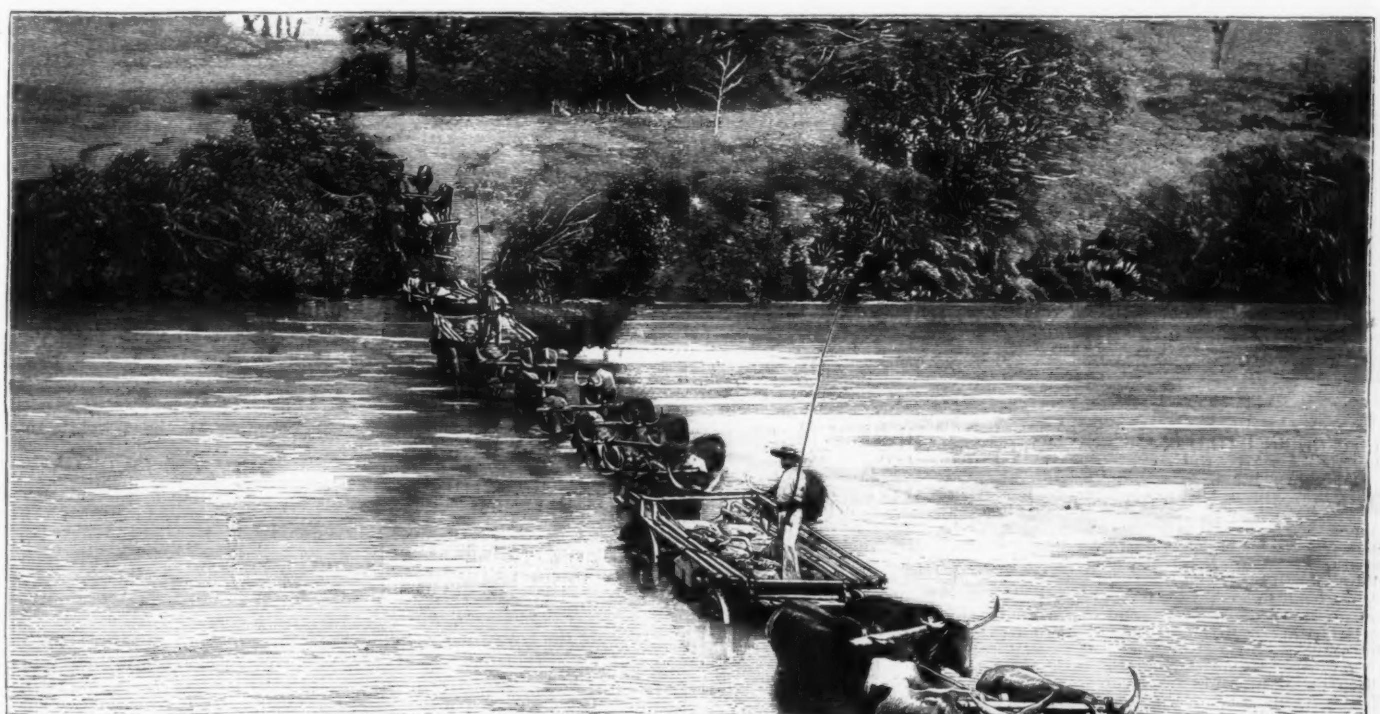
THE LAND OF THE BOERS.

NEVER were the Boers better equipped to resist an invasion than at present. After the Jameson raid they bought guns and ammunition, built forts near Johannesburg and Pretoria, and organized an army with the aid of German and Dutch officers. Their old Martini rifles were superseded by modern Mausers, and the men were drilled in the use of the new weapons. Orange Free State, as well as the Transvaal, is ready for war. The thirty rapid-fire guns which constitute its effective artillery will prove an addition to the Boer forces by no means to be despised.

The reverses which England has met certainly demonstrate that the Boers are well prepared to meet their enemies. But Great Britain must conquer in the end, if it be only by sheer force of numbers.

A nation fighting for independence is always sure of a certain amount of sympathy. One cannot blame the Boers for battling with all their Dutch might for the land which they were the first to settle, and which they acquired only after many a hard-fought struggle with beast and savage. All Africa is divided among the Great Powers. But even if there were land still unclaimed the Boers would cry, with their shrewd, far-sighted Oom Paul: "Let us stay where we are and fight for that which we have. A better land we shall never

THE PRESIDENT OF ORANGE FREE STATE AND HIS ESCORT.



TRANSPORTING MILITARY SUPPLIES IN THE TRANSVAAL.

find. It is the best, the richest in the world." In truth, Krüger by no means exaggerated the natural resources of the Transvaal. With peace and a few necessary reforms the land will in a few years become one of the most prosperous on earth.

Gold, after all, rules mankind. Men bow down before it the world over; for it is the one eternal measurer of values, in terms of which everything, from the crown of a monarch to the spade with which the metal itself is dug, is expressed. With gold we buy our costliest wares, the services of the wisest men, the aid of art and science. With it and for it we wage our wars. But the Transvaal war is fought not alone for the sake of gold and silver, but also of tin and lead, of coal and iron, hidden in the rich earth of the land of the Boers. It is fought for the untold agricultural wealth of the soil as well as for the rights of English residents.

It might be asked: Is there anything which the Transvaal does not possess? With the exception of the lowlands in the sub-tropical northern portion, the country is the healthiest that can be imagined; consumptives and asthmatics have chosen it for their home. Johannesburg, with its excellent water system, its good drainage, can well claim to be one of the healthiest as well as the wealthiest of cities. The deeper the miners sink their shafts, the richer is the gold which they find. The Deep Level Mine last year was so vastly extended that if war had not been declared, the Transvaal would have astonished the world with its gold production for 1899. But in spite of the present trouble there has been an increase of nearly $4,000,000. In quantity of precious metal mined, silver is exceeded only by gold and is followed by iron and coal.

The fauna of the Transvaal was once as rich as its flora; but the deadly rifle of the Boer has well-nigh exterminated most of the wild animals. The elephant, antelope, bison, giraffe, rhinoceros, hippopotamus, zebra, and quagga, together with the ostrich, have been almost exterminated. The lion and the hyena have also been considerably reduced in numbers. Leopards, monkeys, and venomous snakes, on the other hand, are frequently encountered, as well as bright-colored birds and [illegible] butterflies. The angora goat, much sought for its fine fur, is also found on the meadows of the Transvaal. The land is well suited for raising oxen, sheep, goats, and horses; but the breeding of cattle as practiced at present can be vastly improved. The same holds good for agriculture in general and for arboriculture in particular. There are still magnificent woodlands, even virgin forests; but the ravages to which the woods are being subjected must soon end if the Boers wish to preserve the fertility of their soil. In the Zutpans district there are still many mahogany, ironwood, ebony, banana, and quava trees, together with arboreal euphorbia, ferns, and palms of many kinds. In the clearings huge monkey-bread trees are often seen.

In the sub-tropical northern districts are extensive plantations on which coffee, tea, cane sugar, ananas, and cotton are grown. Such fruit-bearing trees as guavas, bananas, dates, oranges, mandarins, lemons, figs and almonds, are also cultivated. In the southern parts, the fruits of the temperate zone—apples, pears, plums, peaches, apricots—are grown. Certain parts are well suited for the cultivation of tobacco; others for the growing of wine grapes. So high is the quality of Transvaal tobacco that the Boers and Uitlanders prefer it to the foreign product and are willing to pay more for it. In the southern and central parts of the country are broad tracts upon which legumes and cereals are grown. Transvaal wheat, owing to its weight and whiteness, received premiums at the last Paris Exposition. But there is a dark side to this picture. Sometimes it happens that during droughts, the harvests are ruined and famine prevails throughout the land. Proper irrigation would remedy the evil. On well-watered soil, wheat grows the year round; when one crop is harvested another is immediately sowed, and the wheat sowed reproduces forty to sixty fold.

It is therefore all the more deplorable that the Transvaal with its area of 291,616 square miles cannot support the sparse population of 288,740 whites and 750,000 blacks, or altogether 1,038,750. The cause is to be found in the wretched laws, under which agriculture on a large scale cannot flourish. Most able-bodied men have, consequently, taken to the gold fields. During the crisis which preceded the war, good land near a railroad could not bring five dollars per acre. Under a liberal and just government the Transvaal would become not only the first gold-producing country in the world, but also the foremost agricultural region in Africa, the granary of the Dark Continent, the purveyor of coal, iron, and machinery to all nations south of the equator.

To Le Monde Illustré and Illustrirte Zeitung we are indebted for our illustrations and descriptive matter.

THE LAND OF THE BOERS—NATIVE MINERS DANCING.

A PROBLEM IN AMERICAN ANTHROPOLOGY.*

While engaged in writing the address that I am to read to you this evening, the sad news reached me of the death, on July 31, of our President of five years ago, Dr. D. G. Brinton. Although not unexpected, as his health had been failing since he was with us at the Boston meeting, where he took his always active part in the proceedings of Section H, and gave his wise advice in our general council, yet his death affects me deeply. I was writing on a subject we had often discussed in an earnest but friendly manner. He believed in an all-pervading psychological influence upon man's development, and claimed that American art and culture were autochthonous, and that all resemblances to other parts of the world were the results of corresponding stages in the development of man; while I claimed that there were too many root coincidences with variant branches to be fully accounted for without also admitting the contact of peoples. Feeling his influence while writing, I had hoped that he would be present to-night, for I am certain that no one would have more readily joined with me in urging a suspension of judgment, while giving free expression to opinions, until the facts have been worked over anew, and more knowledge attained.

Now that his eloquent tongue is silent and his gifted pen is still, I urge upon all who hear me to-night to read his two addresses before this Association—one as Vice-President of the Anthropological Section in 1887, published in our thirty-sixth volume of Proceedings, the other as retiring President in 1895, published in our forty-fourth volume. In these addresses he had, in his usual forcible and comprehensive manner, presented his views of American anthropological research and of the aims of anthropology.

Dr. Brinton was a man of great mental power and erudition. He was an extensive reader in many languages, and his retentive memory enabled him to quote readily from the works of others. He was a prolific writer, and an able critic of anthropological literature the world over. Doing little as a field archæologist himself, he kept informed of what was done by others through extensive travels and visits to museums. By his death American anthropology has suffered a serious loss, and a great scholar and earnest worker has been taken from our Association.

In the year 1857 this Association met for the first time beyond the borders of the United States, thus establishing its claim to the name American in the broadest sense. Already a member of a year's standing, it was with feelings of youthful pride that I recorded my name and entered the meeting in the hospitable city of Montreal, and it was on this occasion that my mind was awakened to new interests which in after years led me from the study of animals to that of man.

On Sunday, August 16, while strolling along the side of Mount Royal, I noticed the point of a bivalve shell protruding from roots of grass. Wondering why such a shell should be there, and reaching to pick it up, I noticed on detaching the grass roots about it that there were many other whole and broken valves in close proximity—too many, I thought, and too near together, to have been brought by birds, and too far away from water to be the remnants of a muskrat's dinner. Scratching away the grass and poking among the shells, I found a few bones of birds and fishes and small fragments of Indian pottery. Then it dawned upon me that there had been an Indian home in ancient times, and that these odds and ends were the refuse of the people—my first shell-heap or kitchen-midden, as I was to learn later. At the time this was to me simply the evidence of Indian occupation of the place in former times, as convincing as was the palisaded town of old Hochelaga to Cartier when he stood upon this same mountainside more than three centuries before.

At that meeting of the Association several papers were read, which, had there been a section of anthropology, would have led to discussions similar to those that have occurred during our recent meetings. Forty-two years later we are still disputing the evidence, furnished by craniology, by social institutions and by language, in relation to the unity or diversity of the existing American tribes and their predecessors on this continent.

Those were the days when the theory of the unity of all American peoples, except the Eskimo, as set forth by Morton in his "Crania Americana" (1839), was discussed by naturalists. The volumes by Nott and Gliddon, "Types of Mankind" (1854) and "Indigenous Races of the Earth" (1857), which contains Meigs' learned and instructive dissertation, "The Cranial Characteristics of the Races of Men," were the works that stirred equally the minds of naturalists and of theologians regarding the unity or diversity of man—a question that could not then be discussed with the equanimity with which it is now approached.

* Address delivered before the American Association for the Advancement of Science, at Columbus, Ohio, on August 21, by Prof. Frederick Ward Putnam, the retiring President of the Association.

The storm caused by Darwin's "Origin of Species" had not yet come to wash away old prejudices and clear the air for the calm discussion of theories and facts now permitted to all earnest investigators. Well do I remember when, during those stormy years, a most worthy bishop made a fervent appeal to his people to refrain from attending a meeting of the Association then being held in this city, on account of what he claimed to be the atheistic teachings of science. Yet ten years later this same venerable bishop stood before us, in that very city, and invoked God's blessing upon the noble work of the searchers for truth.

At the meeting of 1857 one of our early presidents, the honored Dana, read his paper entitled "Thoughts on Species," in which he described a species as "a specific amount or condition of concentrated force defined in the act or law of creation," and, applying this principle, determined the unity of man in the following words:

"We have therefore reason to believe, from man's fertile intermixture, that he is one in species; and that all organic species are divine appointments which cannot be obliterated unless by annihilating the individuals representing the species."

Another paper was by Daniel Wilson, recently from Scotland, where six years before he had coined that most useful word "prehistoric," using the term in the title of his volume, "Prehistoric Annals of Scotland." In his paper Prof. (afterward Sir Daniel) Wilson controverted the statement of Morton that there was a single form of skull for all American peoples, north and south, always excepting the Eskimo. After referring to the views of Agassiz, as set forth in the volumes of Nott and Gliddon, he said, "Since the idea of the homogeneous physical characteristics of the whole aboriginal population of America, extending from Terra del Fuega to the Arctic Circle, was first propounded by Dr. Morton, it has been accepted without question, and has more recently been made the basis of many widely comprehensive deductions. Philology and archæology have also been called in to sustain this doctrine of a special unity of the American race; and to prove that, notwithstanding some partial deviations from the prevailing standard, the American Indian is essentially separate and peculiar; a race distinct from all others. The stronghold, however, of the argument for the essential oneness of the whole tribes and nations of the American continents is the supposed uniformity of physiological, and especially of physiognomical and cranial characteristics; an ethnical postulate which has not yet been called in question."

THE LAND OF THE BOERS—DIVINE SERVICE OF CHRISTIAN KAFFIRS IN THE GOLD-FIELDS.

After a detailed discussion of a number of Indian crania from Canada and a comparison with those from other parts of America, as described by Morton, he makes the following statements: "But, making full allowance for such external influences, it seems to me, after thus reviewing the evidence on which the assumed unity of the American race is formed, little less extravagant to affirm of Europe than of America, that the crania everywhere and at all periods have conformed, or even approximated, to one type."

"As an hypothesis, based on evidence accumulated in the 'Crania Americana,' the supposed homogeneity of the whole American aborigines was perhaps a justifiable one. But the evidence was totally insufficient for any such absolute and dogmatic induction as it has been made the basis of. With the exception of the ancient Peruvians, the comprehensive generalizations relative to the Southern American continent strangely contrast with the narrow basis of the premises. With a greater amount of evidence in reference to the northern continent, the conclusions still go far beyond anything established by absolute proof; and the subsequent labors of Morton himself, and still more of some of his successors, seem to have been conducted on the principle of applying practically, and in all possible bearings, an established and indisputable scientific truth, instead of testing by further evidence a novel and ingenious hypothesis."

At the close of this instructive paper are the following words: "If these conclusions, deduced from an examination of Canadian crania, are borne out by the premises and confirmed by further investigation, this much at least may be affirmed: that a marked difference distinguishes the northern tribes, now or formerly occupying the Canadian area, in their cranial conformation, from that which pertains to the aborigines of Central America and the southern valley of the Mississippi; and in so far as the northern differ from the southern tribes, they approximate more or less, in the points of divergence, to the characteristics of the Eskimo: that intermediate ethnic link between the Old and the New World, acknowledged by nearly all recent ethnologists to be physically a Mongol and Asiatic, if philologically an American."

The third paper of the meeting to which I shall refer was by another of our former presidents, the then well-known student of Indian institutions and the author of the "League of the Iroquois" (1851). In this paper, on "The Laws of Descent of the Iroquois," Morgan discusses the league as made up of five nations, each of which was subdivided into tribes, and he explains the law of marriage among the tribes, the family relationship and the descent in the female line, as essential to the maintenance of the whole system. He then says:

"Now the institutions of all the aboriginal races of this continent have a family cast. They bear internal evidence of a common paternity, and point to a common origin, but remote, both as to time and place. That they all sprang from a common mind, and in their progressive development have still retained the impress of original elements is abundantly verified. The Aztecs were thoroughly and essentially Indian. We have glimpses here and there at original institutions which suggest at once, by their similarity, kindred ones among the Iroquois and other Indian races of the present day. Their intellectual characteristics, and the predominant features of their social condition, are such as to leave no doubt upon this question; and we believe the results of modern research, upon this point, concur with this conclusion. Differences existed, it is true, but they were not radical. The Aztec civilization simply exhibited a more advanced development of those primary ideas of civil and social life which were common to the whole Indian family, and not their overthrow by the substitution of antagonistic institutions."

After calling attention to the fact that a similar condition exists among certain peoples of the Pacific Islands, he writes: "Whether this code of descent came out of Asia or originated upon this continent is one of the questions incapable of proof; and it must rest, for its solution, upon the weight of evidence, or upon probable induction. Its existence among American races, whose languages are radically different, and without any traditional knowledge among them of its origin, indicates a very ancient introduction, and would seem to point to Asia as the birthplace of the system."

It would be interesting to follow the succeeding meetings of the Association, and note the recurring presentation of views which the quotations I have given show to have been most seriously discussed over a generation ago. A historical review of the literature of American anthropology during the present century would also be interesting in this connection. It is probable, however, that a review of this literature for the first half of the century would reveal the fact that the writers, with here and there a notable exception, were inclined to theorize upon insufficient data, and devoted little time to the accumulation of trustworthy facts. The presentation and discussion of carefully observed facts can almost be said to have begun with the second half of the century, and this is the only part of the subject that now commands serious attention.

A reference to the very latest résumé of this subject as presented in the "History of the New World called America," by Edward John Payne (vol. ii., Oxford, 1899), is instructive here. In this volume Mr. Payne admits the great antiquity and unity of the American tribes, which he considers came from Asia in pre-Glacial and Glacial times, when the northwestern corner of America was connected with Asia, and when man "as yet was distinguished from the inferior animals only by some painful and strenuous form of articulate speech and the possession of rude stone weapons and implements, and a knowledge of the art of fire-kindling. Su[illegible] be supposed, were the conditions under which man inhabited both the old and the new world in the paleo-ethnic age. . . . Even when a geological change had separated them (the continents), some intercourse by sea was perhaps maintained—an intercourse which became less and less, until the American branch of humanity became practically an isolated race as America itself had become an isolated continent" (Preface).

Mr. Payne discusses the growth of the languages of America, the various social institutions and arts, and the migrations of these early savages over the continent, north and south, during the many centuries following, as one group after another grew in culture. He considers all culture of the people autochthonous. In writing upon the physical characters of the people, he says: "It may, however, be suggested that, as in the Old World, the earlier and the smaller tribes tend to dolichocephaly, while the better developed ones are rather brachycephalous, a conclusion indicating that the varying proportions of the skull should be taken less as original evidence of race than as evidence of physical improvement."

This volume by Mr. Payne is replete with similar

statements of facts and theories, and shows how difficult it is for us to understand the complications of the subject before us. It cannot be denied that, taking into consideration the number of authors who have written on this subject, Mr. Payne is well supported in his theory of the autochthonous origin of all American languages, institutions and arts; but the question arises, Has not the old theory of Morton, the industrious and painstaking pioneer of American craniology, been the underlying cause of this, and have not the facts been misinterpreted? At the time of Morton, the accepted belief in the unity and universal brotherhood of man was about to be assailed, and it seems, as we now look back upon those times of exciting and passionate discussions, that Morton may have been influenced by the new theory that was so soon to become prominent, namely, that there were several distinct creations of species of the genus Homo, and that each continent of great area had its own distinct fauna and flora. Certainly Morton ventured to make a specific statement from a collection of crania which would now be regarded as too limited to furnish true results.

The anthropologist of to-day would hardly venture to do more than to make the most general statement of the characters of any race or people from the examination of a single skull, although after the study of a large number of skulls from a single tribe or special locality he would probably be able to select one that was distinctly characteristic of the special tribe or group to which it pertained.

Relatively long and narrow heads and broad and short heads occur, almost everywhere in greater or less proportion. In determining the physical characters of a people, so far as this can be done from a study of crania, the index of the height of the skull is quite as important as that of its breadth. These indices simply give us the ready means of expressing by figures the relative height and breadth of one skull in comparison with another—a small part of what the zoologist would consider in describing, for instance, the skulls of different species of the genus Canis. So in our craniological studies we should determine the relative position, shape and proportions of the different elements of the skull. In fact, we should approach the study of human crania with the methods of the zoologist, and should use tables of figures only so far as such tables give us the means of making exact comparisons. Here again are the anthropologists at a disadvantage, inasmuch as it is only very recently that we are approaching a standard of uniformity in these expressions. It is now more than ever essential that anthropologists should agree upon a method of expressing certain observed facts in somatology, so that the conscientious labors of an investigator, who has a special opportunity for working upon one group of man, may be made available for comparison by investigators of other groups.

Probably the old method, still largely in vogue, of stating averages is responsible for many wrong deductions. If we take one hundred or more skulls of any people, we shall find that the two extremes of the series differ to a considerable extent from those which naturally fall into the center of the series. These extremes in the hands of a zoologist would be considered the sub-varieties of the central group or variety. So in anthropology, we should take the central group of the series as furnishing the true characters of the particular variety or group of man under consideration, and should regard the extremes as those which have been modified by various causes. It may be said that this central group is defined by stating the mean of all the characters; but this is hardly the case, for by giving the mean of all we include such extraneous characters as may have been derived by admixture or from abnormal conditions.

The many different characteristics exhibited in a large collection of crania, brought together from various portions of America, north and south, it seems to me, are reducible to several great groups which may be generally classed as the Eskimo type, the northern and central or so-called Indian type, the northwestern brachycephalic type, the southwestern dolichocephalic type, the Toltecan brachycephalic type, and the Antillean type, with probably the ancient Brazilian, the Fuegian and the pre-Inca types of South America. Each of these types is found in its purity in a certain limited region, while in other regions it is more or less modified by admixture. Thus the Toltecan or ancient Mexican type (which, united with the Peruvian, was separated as the Toltecan family even by Morton) occurs, more or less modified by admixture, in the ancient and modern pueblos and in the ancient earthworks of our central and southern valleys. In Peru, more in modern than in ancient times, there is an admixture of two principal types. At the north of the continent we again find certain traits that possibly indicate a mixture of the Eskimo with the early coast peoples both on the Pacific and on the Atlantic sides of the continent. The North-Central Indian type seems to have extended across the continent and to have branched in all directions, while a similar but not so extensive branching, northeast and south, seems to have been the course of the Toltecan type.

This is not theorizing upon the same facts from which Morton drew the conclusion that all these types were really one and the same. Since Morton's time we have had large collections of crania for study, and the crania have been correlated with other parts of the skeleton and with the arts and institutions of the various peoples.

Although these relations have been differently interpreted by many anthropologists who have treated the subject, yet to me they seem to indicate that the American continent has been peopled at different times and from various sources; that the great lapse of time since the different immigrants reached the continent has in many places brought about an admixture of the several stocks and modified to a greater or less extent the arts and customs of all, while natural environment has had a great influence upon the ethnic development of each group. Furthermore, contact of one group with another has done much to unify certain customs, while "survivals" have played an active part in the adoption and perpetuation of arts and customs not native to the people by whom they are preserved.

(To be continued.)

RECENT WORK AGAINST THE GYPSY MOTH.

THE attempt on the part of the State of Massachusetts to eradicate the gypsy moth (Porthetria dispar) has been generally considered as one of the largest problems in modern economic entomology. The conditions involve the extermination of a highly prolific polyphagous species well established over an area of more than two hundred square miles containing within its borders the varied features of villages, cities, parks, farms and woodlands.

In his paper, "Recent Work Against the Gypsy Moth," read before the Association of Economic Entomologists at the late meeting of the American Association for the Advancement of Science at Columbus, Ohio, E. H. Forbush, of Malden, Mass., Field Director of the Mass. Board of Agriculture, presented a review of the State gypsy moth work and the results achieved to date. The unfortunate introduction of the gypsy moth into America occurred about 1869, but the insect, so far as known, is still confined to a limited area in eastern Massachusetts, comprising mainly towns lying north of Boston. The importing medium in the matter of the moth's introduction was Prof. L. Trouvelot, a French savant, residing at that time in Medford, a town in the suburbs of Boston. The moth is known to have been imported into Massachusetts in connection with some experimental purpose by M. Trouvelot, who was interested in the matter of raising silk from native silk worms. While the exact manner of the moth's introduction and subsequent escape is not clearly known, the insect was undoubtedly imported in the egg form and escaped in some numbers from the experimenter's hands. One local tradition is to the effect that eggs of the moth were blown out of doors from the sill of an open window. This happened quite by accident, and the conscientious scientist notified the town authorities of his loss and of the possible serious consequences that might ensue.

M. Trouvelot later returned to France, and for a time the pest was unheard of. Apparently, the moth required a considerable time to develop strength and fertility under the unfavorable conditions of a new and harsher climate, but after twelve years from the time of its introduction it had become a serious nuisance in the neighborhood where it had escaped. The moth, still supposed to be some destructive native insect, was vigorously fought by many citizens, but all efforts to exterminate or even suppress it failed. At last came the year of the famous moth outbreak in Medford, 1889. The armies of "worms" that suddenly appeared in June and July seemed about to destroy every green thing. They gathered in masses sufficient to blacken the houses and fences in certain sections and devastated all sorts of foliage over extensive tracts, killing many trees. The huge, hairy, full-grown caterpillars were constantly dropping on people on the sidewalks beneath the trees, while the smaller larvæ, hanging by invisible threads, were swept into the eyes and upon the faces and necks of passers. The myriads that were crushed under foot on the sidewalks gave the streets a filthy and unclean appearance. Prominent citizens of Medford have testified that the "worms" were so numerous that one could slide on the crushed bodies on the sidewalks; and that they entered the windows of houses, destroying flowering plants, and even appearing in the chambers at night. In the warm, still summer nights a sickening odor arose from the mass of caterpillars and pupæ in the woods and orchards, and a constant shower of excrement fell from the trees.

The destruction of trees was greatest in those localities where the moth had been longest abundant, for, though the smaller plants were often killed in one season, as were also the less hardy trees, those trees which were lusty and vigorous would frequently stand defoliation for two or three successive years before they finally gave up their hold on life.

"We had three apple trees, four pear trees, one plum tree, and one mountain ash killed by the gypsy moth caterpillars. The apple trees were good-sized trees," says one sufferer.

"The moths ruined me as regards fruit. Their ravages caused me to lose five nice apple trees, two cherry trees, one pear tree, and five plum trees," says another.

A third describes the manner in which trees were killed: "Two large apple trees were stripped by the caterpillars and died. They stripped the trees early in the season, and, as they continued their ravages for nearly the whole summer, the trees had no chance to recover. The next year the trees would leaf out and be stripped again, and so on, until unable any longer to stand such treatment, they died."

KILLING EGGS OF THE GYPSY MOTH ON A LARGE ELM TREE AT MALDEN, MASS.

The caterpillars destroyed not only the foliage of the trees, but also fruit and vegetables. Their long period of feeding made it possible for the larvæ to secure a great variety of food. When the supply of leaves from the trees fell short (and oftentimes before), they attacked the gardens. Little was spared but the horse chestnut trees and the grass in the fields, though even these were eaten to some extent. When fruit trees were stripped of their leaves, the mature fruit either failed to develop or dropped from the tree. In some cases the fruit itself was partially eaten by the voracious caterpillars. The destruction of berries was often as complete. Many vegetables were ruined; flower gardens were destroyed, and even greenhouses were invaded and rose bushes and other flowering plants eaten.

In the fight to save trees and gardens, countless numbers of caterpillars were killed in all sorts of ways by the citizens; but, in spite of all efforts, the horde of larvæ began to assume the aspect of a plague. The serious conditions are well set forth by extracts from

the testimony of reputable residents of the infested portions of Medford:

"When the caterpillars had cleaned out Mrs. Spinney's trees, they started across the street in droves and filled the orchards on the other side, and the next morning you could see the path which they had made across the street."

"I used to fairly dread going down street to the station. It was like running a gauntlet. I used to turn up my coat collar and run down the middle of the street. One morning, I remember that I was completely covered with caterpillars, inside my coat as well as out."

"As fast as we gathered them (the caterpillars) others would take their places. They seemed to come like a flock of sheep."

"The caterpillars were thickest in Glenwood, where in places they were like a carpet on the ground."

"I have seen the caterpillars crawling in great numbers on the rails of the Medford branch track. After the train had gone along, the rails would be green with their crushed bodies."

"The caterpillars were so numerous that when they clustered on the trunks they would lap over each other. Their eating in the trees sounded just like a breeze. Many got into the house, and we could not open the windows. I found them in the kitchen and in the bedrooms. I used to find them in the beds when I turned down the blankets."

"The caterpillars covered one side of my house so thickly that you could not have told what kind of paint was on it. It was impossible to keep them entirely out of the house. The women had to shake their clothing when they went into the house."

"All the orchards in this section were completely ravaged, and there was no fruit. The caterpillars simply swarmed. I destroyed thousands of them by burning them with rags soaked in kerosene. I spent many hours in destroying them, but without making any perceptible difference in their numbers. They were over everything and even got into the cellars. Some of my apple trees overhang my shop; in the evening, when the caterpillars were liveliest, the noise of their droppings falling on the shingles sounded like a steady shower. The gutter was brimful and running over with their droppings."

"When the caterpillars were thickest on the trees, we could plainly hear the noise of their nibbling at night when all was still. It sounded like the pattering of very fine rain drops. If we walked under the trees, we got nothing less than a shower bath of caterpillars. They spun down from the trees by hundreds, even when they were of a large size. We had tarred paper around the trees but they crawled up the trunks in masses and went right over the paper. The bodies of those that got stuck in the printer's ink served as a bridge for their brethren. The caterpillars were so thick on the trees that they were stuck together like cold macaroni. We always tapped the screen doors when we opened them, and the monstrous great creatures would fall down, but in a minute or two would crawl up the side of the house again. A little later in the season we saw literally thousands of moths fluttering in the back yard. In the fall the nests were stuck all over the street trees."

During this famous summer of 1889, the new pest had been identified as the gypsy moth, specimens having been sent to the State experiment station, and, in the absence of Dr. C. H. Fernald, entomologist to the Board of Agriculture, named by his wife, herself an accomplished entomologist.

In addition to the efforts of the citizens, action was taken by the town of Medford, in 1889, to suppress the moths by banding the trees and destroying eggs. But by the fall it was realized that the nuisance was too widespread to be coped with by the local authorities. The State was accordingly petitioned for aid, and in 1890 the legislature appropriated $50,000 for the extermination of the gypsy moth, the work to be carried on by a salaried commission. A year later an act of the legislature placed the work in the hands of the State Board of Agriculture, the act directing the Board "to provide and carry into execution all reasonable measures to prevent the spreading and to secure the extermination of the Ocneria dispar or gypsy moth in this commonwealth." Since 1891 the State exterminative work has been conducted by the Board of Agriculture, under direction of its unsalaried "Committee on the Gypsy Moth, Insects and Birds," Dr. C. H. Fernald serving as entomologist to the committee and E. H. Forbush as field director.

With the close of the year 1899 the State of Massachusetts will have expended in annual appropriations for the gypsy moth work the sum of $1,155,000. The magnitude of the undertaking was by no means realized in 1890, when the commonwealth assumed the task of exterminating the gypsy moth. The insect was then supposed to be confined to cultivated lands in the town of Medford only, the infested district not being supposed to exceed one-half mile in width and a mile and a half in length. But the experience of the first year showed that the insect was not confined to Medford, and the commission of 1890 reported that fifty square miles were infested. The work of the Board of Agriculture in succeeding years has shown that the moth is distributed over an area of more than two hundred square miles, not only in cultivated lands, but in waste and woodlands as well. It should be noted that the moth has not spread over such an extent of country since 1890 as has sometimes been the impression. The age of many of the moth colonies found indicated that the insect had become more or less well established in the present infested territory as early as 1891, the year of its greatest abundance in Medford, 1889, having been also the year of its greatest distribution. It should be further noted that, contrary to the prevalent impression, the gypsy moth is not generally distributed throughout the so-called "infested region," but occurs here and there (often at great intervals) in isolated spots, technically known as "colonies."

The magnitude of the task undertaken by the commonwealth of Massachusetts in its attempt to exterminate the gypsy moth is indicated forcibly by figures relating to the work done from year to year. In the first six weeks' work of 1881 a careful estimate showed the number of egg clusters of the moth destroyed to [illegible] 760. The number of eggs contained in [illegible] would probably have been from three to five hundred millions. The use of burlap bands placed about the trees to serve as artificial hiding places for the caterpillars, where they might later be destroyed, has increased from year to year until in 1899, 53 tons of burlap were purchased for the purpose of banding, approximately, 2,500,000 trees. This is in addition to about a million trees on which the burlaps of the previous year were still in serviceable condition. The number of caterpillars destroyed by hand beneath burlap bands amounted in 1896 to 1,808,105, and in 1895 to 2,164,458. The year 1895 was a famous caterpillar year. The very early season caused a rapid development of the caterpillars, and they spread for a time almost unhindered by man, owing to legislative delay in making an appropriation, which caused the entire loss of the Board's spring work. So serious were the conditions in one badly infested woodland colony that the trees over ten acres were cut and burned and the spot left a blackened waste. In one small grove in Dorchester (Boston), where the trees were defoliated before the caterpillars were discovered, 18 bushels of caterpillars were killed in a short time. The delay and reduction of twenty-five per cent. of the appropriation for the work so hindered the Board in its plans that the moth spread in this year to a large extent in the great forest area within the bounds of the infested territory.

The number of trees inspected in 1898 was over 12,000,000; in 1895 the large figure of over 14,000,000 trees inspected was reached. This yearly inspection of trees includes also the spring and fall search for and destruction of eggs. In one year (1896) over 800,000 egg clusters were killed by hand treatment with creosote. But figures give only an inadequate idea of the number of forms of the moth destroyed from year to year. Millions of eggs have been destroyed by cutting and burning infested trees and underbrush. Caterpillars have been killed en masse by spraying and burning. Where such wholesale methods have been applied, no attempts have been made to even estimate the total of forms of the moth destroyed.

In summarizing the results of the work for the first half of 1899, Field Director Forbush says that it was decided to concentrate the effort of the year on the burlaping period. At the height of the larval season 570 men were employed, and the caterpillars were killed off so rapidly that few matured. The spraying with arsenate of lead in the rainless months of May and June was most effective, nearly, if not quite, all of the caterpillars in the sprayed trees being destroyed. As in past years, more caterpillars were found in the central towns than anywhere else in the infested district. It is difficult now to find egg clusters of the gypsy moth in the infested region, except in a few localities where, owing to delay in making the 1899 appropriation, the woodland has not yet been prepared for the use of burlap by cutting out the undergrowth and dead trees.

It might be inferred from the foregoing statements that the gypsy moth in Massachusetts is nearly exterminated, were it not for the appearance of the insect during the past summer in two new places, Newton and Georgetown. The presence of the moth in both places was readily explained by the fact that there had been vehicular communication between the infested estates and old moth-centers. It was apparent that these two isolated colonies had been in existence for years and that, as in other notorious cases, they were started when the moth had reached its most destructive height in those localities from which the seed-caterpillars came. Neither of these "finds" need of themselves cause any great apprehension, but they at once raise the question as to how many more infested localities remain as yet unfound. While the future danger of the distribution of caterpillars has now been done away with by the great reduction of their numbers, the exact condition of the infested region can only be determined by a careful fall inspection. The indications are that Porthetria dispar will be a rare insect in Massachusetts in the year 1900.

While golden opportunities for progress in this work were lost to the State through the inadequate and delayed appropriations of the earlier years, the numbers of the moth have been reduced, its spread checked, its damage reduced to a minimum and its extermination secured in hundreds of localities and even through entire towns. In thus protecting the property of her own citizens against this insect, Massachusetts has protected the agricultural interests of the entire country. Economic entomologists urge that the work is of national importance; that if the insect is allowed to spread, it will certainly invade other States and eventually become a pest in all parts of the country. In any attempt by Massachusetts to obtain the assistance of the general government in the work of extermination, the fact that the State is continuing the work at great expense will be the best argument that can be presented. In his exhaustive report on "The Gypsy Moth in America" (Bull. No. 11, New Series, U. S. Dept. of Agr.) Dr. L. O. Howard, Entomologist to the United States Department of Agriculture, says: "The State of Massachusetts is most heartily to be congratulated upon the manner in which this work has been carried on. The effort of the State will rank as one of the great economic experiments in the history of the world. It is undoubtedly safe to say that the money which has been and will be spent by the State in this work is but as a drop in the bucket to the loss which would have been occasioned by the insect had it been allowed to spread unchecked. This loss would have fallen not only upon the State of Massachusetts, but upon other States of the Union, so that we may say that the State work has not only been wisely done, but that it has been patriotically done. At the present time there can be little doubt that the extermination of the insect is possible and that it will be only a question of a few years if adequate appropriations are continued."

SINGLE CHINA ASTER (CALLISTEPHUS HORTENSIS).

Color of the flowers pale rose mauve, and bright yellow disk.

SINGLE CHINA ASTER (CALLISTEPHUS HORTENSIS).

THE China Aster (Aster chinensis of Linnæus), which, by the way, is not an Aster any more than a Water-lily is a Lily, was introduced from China to France by a missionary 170 years ago, since when horticulturists have so modified and diversified its characters that we have almost as many forms of it as of Chrysanthemum. Mr. Barron prepared a list of the China Asters specially grown at Chiswick in 1888, in which he enumerated no fewer than seventeen sections, bearing such names as Quilled, Pæony, Pyramidal, etc. That so great a degree of variation has been obtained within the limits of one species without hybridization is remarkable. Probably many who have seen the wild type as here represented, for the re-introduction of which, a year or two ago, we are again indebted to a French missionary in China, are of opinion that as an ornamental garden plant it is superior to most of its garden descendants. At Kew it has been largely used this year as a group plant in the herbaceous borders, and during September and October it has been as much admired by visitors as any plant grown there. It is more elegant because looser and taller than the double-flowered forms, its height being 12 to 18 inches, freely branched, and clothed with healthy, dark green foliage and numerous flowers, from 3 to 5 inches across, colored pale rosy mauve, with a broad, rounded, bright yellow disk. The plant ripens seeds

[illegible] November, 1899.

freely, and the flowers last a week or more if cut and placed in water. Market growers of flowers look upon it as a very promising plant for their purposes.

We are indebted to The Gardeners' Chronicle for the article and engraving.

COTTON INDUSTRY.

THE English Board of Trade returns for the past month respecting the total shipments of cotton piece goods show an increase on the same month of last year and the year before. The figures for the past nine months are 4,096,376,400 yards; the amount for the same period in 1898 was 3,842,208,100 yards.

The countries showing an increase this year on the same period in 1898 are:

	Yards.
Bombay	95,900,000
Bengal and Burma	63,600,000
Foreign West Indies	36,600,000
China	25,300,000
Morocco	23,600,000
Venezuela	21,500 000
U. S. of America	18,600,000
Central America	10,000,000
Chile	10,000,000
Philippine Islands	9,300,000
Madras	8,700,000
Egypt	6,300,000
Dutch Possessions in India	5,800,000
West Coast of Africa, Foreign	5,500,000
Portugal	5,500,000
Persia	5,300,000
Mexico	4,500,000
West Coast of Africa, British	4,100,000
Republic of Colombia	3,600,000
Canada	3,600,000
Australasia	3,300,000
Greece	2,700 000
France	1,700,000
Argentine Republic	1,300,000

The chief cases of decrease are:

Brazil	47,800,000
Turkey	40,000,000
Japan	23,700,000
Straits Settlements	14,600,000
Germany	8,600,000
British Possessions in South Africa.	5,600 000
Uruguay	2,700,000
Malta	900,000
British West India and Guiana	800,000
Italy	800,000
Austrian Territories	500,000

A feature of interest in the English shipments so far this year is that India has taken about 44 per cent. of the total exports of calico. China has done fairly well, and so has the United States. Japan is doing a little better at the moment, but during the last three-quarters of the year she has disappointed Lancashire. Manufacturers in England continue, on the whole, deeply engaged for some months to come. All available looms are fully at work, and it would not be surprising, in view of the present state of affairs, to see more loom sheds erected in North and Northeast Lancashire. The margin between cotton and cloth and between yarn and cloth has been more remunerative than for some time back. The whole appearance of the weaving trade is healthy, with no discouraging prospects for the next six months. The recent upward movement in cotton has restricted business to an important extent; that is to say, few contracts from the great consuming markets of the East have been placed at the advanced quotations. Business, in point of fact, has been upset. Until the raw material assumes its normal state, trade will not be fully resumed. The home department is also healthy, with no special feature worth mentioning.

English shipments of cotton yarn for last month were pretty much the same in weight as in the corresponding month of last year, but the aggregate shipments for the past nine months do not look well as compared with the same three-quarters of the year 1898. The amount for the nine months ended September 30, 1899, was 160,214,100 lb., while for the same period in 1898 the amount was 184,140,400 lb.

Lancashire spinners from American cotton for home consumption have all this year experienced a fairly remunerative trade. Just now, as previously stated, business has been largely restricted by the important advance in cotton. Users of cop twist and weft have operated very sparingly indeed. We should say that during the last month scarcely one-third of the output of the spindles has been sold, still producers have heavy order books, though they are lighter than a month ago. The production is fully absorbed by the looms, no stocks being heard of in any direction. There are a number of new mills being built, and last week several additional factories were projected. It looks as if in twelve months' time from now there will be close upon 1,000,000 more spindles running than to-day. Shipping yarns have rather lagged behind. Bolton spinnings have been very strong indeed. It is a long time since the finer counts were so deeply under contract.

Mr. Henry Neill has made a statement of a definite character relating to the probable growth of the American cotton crop. He considers that there will be a yield of at least 11,000,000 bales, however early a real killing frost may come. These figures are to be looked upon as his minimum estimate. Other authorities have given out lower figures, and it remains to be seen what the output will be. In the meantime Lancashire spinners, on the whole, are putting their faith in Mr. Neill. During all the recent excitement they have bought sparingly on spot, not being disposed to follow the upward course of prices. The Egyptian cotton crop is understood to be of satisfactory dimensions.

An agitation is on foot among cotton operatives to reduce the hours of labor by one hour, the present legal time being 56½ hours. The Cotton Employers' Parliamentary Association, which covers the whole of the staple industry, are preparing to strongly oppose the proposal in view of the keen competition abroad and the longer hours worked there. The masters' secretary (Mr. W. Tattersall) has asked the Foreign Office for a return of the hours of labor in foreign cotton mills.—Economist.

MISCELLANEOUS NOTES.

The New York Lumber Trade Journal, in one of its recent issues, gives an estimate of how much lumber was used in the stands for the Dewey parade, and places the amount at 7,758,904 feet. The Lumber Trade Journal has, it says, made a fairly complete canvass, and adds that the stock was furnished by thirty-five concerns. With an average value of $22.50 per 1,000, which it says is a very conservative estimate, the total cost of the lumber was $174,575.32.

A new pneumatic cyanide process, known as the Johnson process, consists of expressing the water out of the slimes, obtained from the mills by means of a filter press, displacing the moisture and soluble cyanocides in the filter cakes formed in the press, by cyanide or potassium solution. The press is opened and the cakes of slimes dropped into a vortex mixing vat, containing cyanide of potassium solution, which is arranged so that air can be drawn into the vortex, facilitating the working of the cyanide. After the proper amount of cake and cyanide solution have been placed into the mixing vat, the agitator having been previously set in motion, the gold is brought into solution. The slimes are passed through a valve into a second receiver and forced into the leaching press. The gold leaves this press in solution and is run over boxes containing fine zinc, precipitating the gold in a metallic form. The cyanide containing gold that may be left in the filter cakes is displaced by pure water.—Mining and Scientific Press.

Attention has been drawn in France to an alcoholic liquor, very rich in aromatic principles, resembling "Schnaps." This spirit is prepared in Algeria by the fermentation of the juice expressed from the fruit of a species of cactus, opuntia, commonly called the Barbary fig. This cactus, which is very abundant in the south of France and north of Africa, prefers localities which, on account of the intense heat and absence of moisture, are quite sterile for other plants. One hundred grammes of the fruits yield juice containing 14·5 gramme of sugar, and, after a few days' fermentation, 45 to 60 grammes of pure alcohol is obtained per kilogramme of fruits. The systematic cultivation of the cactus has been proposed in France for the utilization of land otherwise barren. One cactus plant yields 100 to 200 kilogrammes of fruit per annum, and 90 to 100 plants could be grown per hectare. Thus the annual yield of absolute alcohol would be 500 to 700 liters per hectare, with a minimum of trouble and cost.—Zeits. für Spiritusind.

"**The first** of August was the tenth anniversary of the introduction of the zone system on the Hungarian state railroads, and the following figures are given to illustrate the results which have followed," says The Railway Gazette. "The number of passengers carried (000 omitted) and the length of railroad worked have been:

	1888.	1889.	1890.	1892.	1896.	1898.
Miles	2,829	3,158	3,215	4,755	4,876	4,956
Passengers	5,048	8,915	15,691	28,624	35,442	33,146

"With an increase of 75 per cent. in mileage from 1888 to 1898 there was an increase of 557 per cent. in the number of passengers carried. The passenger earnings meanwhile increased 215 per cent. The maximum travel and earnings were in 1896, when a great millennial celebration of the establishment of the kingdom of Hungary greatly stimulated travel. The passenger mileage is not reported. Per mile of road, the number of passengers has increased 270 per cent. and the passenger earnings 77 per cent. The earnings per mile were only $1,003 in 1888 and rose to $1,775 in 1898. The passenger business of the Hungarian railroads is still light, and considering the population and the railroad mileage is very light; but it has undoubtedly been enormously stimulated by the low rates of the zone tariff. Those who have paid attention to this tariff will remember that tickets at zone rates are not sold for journeys through Buda-Pesth. You must pay for a ticket to Buda-Pesth and for one for the distance beyond Buda-Pesth, though very likely the whole distance, if on a route not passing the capital, would call for no more than the Buda-Pesth rate. It is now reported that other places in the kingdom are to be similarly favored, which will be equivalent to limiting the distances in the longer zones."

American Almonds and Cocoanuts.—"There are, roughly speaking, 21,000,000 pounds of almonds consumed in the United States each year, some eaten with raisins, some used in the manufacture of candy, some ground for cream and flavoring extracts and some of an inferior quality used for perfumery and soap," says The Boston Transcript. "The State of California produces about 14,000,000 pounds of almonds in a year, or two-thirds of the amount required for domestic consumption, and the other almonds are imported from European countries, from which, until a few years ago, all the almonds were sent. The figures of almond importations for the fiscal year 1898 show importations of about 7,000,000 pounds. Of this amount 4,500,000 came from Spain, 1,500,000 from Italy, chiefly Sicily, and the balance from Greece and Portugal. Cocoanuts to the value of about $600,000 a year are imported into the United States from foreign countries or from countries which were under foreign jurisdiction at the time of the last annual Treasury report. Before the beginning of the Cuban war for independence the importation of cocoanuts from Cuba into the United States was to the value of about $200,000 a year. With the beginning of the war it declined, and under the present tariff the duty on cocoanuts further reduced the importation from Cuba, though a large increase in the shipments of cocoanuts is expected this year under American jurisdiction in Cuba and Porto Rico. The competition of American with foreign cocoanuts, the latter from the West Indies and South American states, has been more active than in the case of almonds for the reason that the chief source of supply of American cocoanuts is Florida, which is in closer proximity to the New York market. The annual product of Florida cocoanuts amounts to about 7,000,000 pounds, of the value of about $300,000 a year, and the conditions as to almonds and cocoanuts are in this particular reversed. California produces just twice as many almonds as are imported into the United States, whereas Florida produces just one-half as many cocoanuts as are imported."

SELECTED FORMULÆ.

To make iron take a bright polish like steel, pulverize and dissolve in 1 quart of hot water 1 ounce of blue vitriol, 1 ounce of borax, 1 ounce of prussiate of potash, 1 ounce of charcoal, ½ pint of salt, all of which is to be added to 1 gallon of linseed oil and thoroughly mixed. To apply, bring the iron or steel to the proper heat and cool in the solution.

Oil for Floors.—

1.	Neatsfoot oil	1 part.
	Cottonseed oil	1 "
	Petroleum oil	1 "
2.	Beeswax	8 "
	Water	56 "
	Potassium carbonate	4 "

Dissolve the potash in 12 parts of water; heat together the wax and the remaining water till the wax is liquefied; then mix the two and boil together until a perfect emulsion is effected. Color, if desired, with a solution of annatto.

3.	Paraffin oil	8 parts.
	Kerosene	1 "
	Lime water	1 "

Mix thoroughly. A coat of the mixture is applied to the floor with a mop.—Pharmaceutical Era.

Expectorant Mixtures.—

EXPECTORANT NO. 1.

Ammon. chloride	1	dr.
Potass. chlorate	24	grs.
Extract licorice	30	"
Spt. aether nit	2	drs.
Sirup senega	2	"
Cinnamon water, enough to make	2	ozs.

Dose: One teaspoonful.

EXPECTORANT NO. 2.

Morphine sulphate	1	gr.
Acid. hydrocyanic dilute	30	mms.
Camphor water, enough to make	2	ozs.

Dose: One teaspoonful.

EXPECTORANT NO. 3.

Tinct. opii deodorat	1	fl. dr.
Sodium bromide	1	dr.
Ammon. chloride	30	grs.
Glycerin	1½	fl. ozs.
Sirup tolu, enough to make	3	"

AMMONIA EXPECTORANT.

Ammon. chloride	1	dr.
Potass. chlorate	30	grs.
Paregoric	2	fl. drs.
Sirup of ipecac	2	"
Sirup wild cherry, enough to make	2	fl. ozs.

Dose: One teaspoonful.

EUCALYPTUS MIXTURE.

Ext. eucalypti fld	2	fl. drs.
Ammon. chlorid	1	dr.
Extract licorice	1	dr.
Sirup tolu, enough to make	2	fl. ozs.

Dose: One teaspoonful.

GUAIACUM MIXTURE.

Potass. chlorate	1	dr.
Tincture guaiac	3½	"
Tincture rhubarb	1½	"
Sirup wild cherry, enough to make	3	fl. ozs.

Dose: One teaspoonful.—American Druggist.

Cleaning Wall Paper.—The following has been recommended: Mix together 1 pound each of rye flour and white flour into a dough, which is partially cooked and the crust removed. To this 1 ounce of common salt and ½ ounce of powdered naphthalin are added, and finally 1 ounce of corn meal and ½ ounce of burnt umber. The composition is formed into a mass, of the proper size to be grasped in the hand, and in use it should be drawn in one direction over the surface to be cleaned.

A method recommended by a practical painter and decorator is to take a soft, flat sponge, being careful that there are no hard or gritty places in it, then get a bucket of new, clean, dry, wheat bran from the mill or feed store. To use it, hold your sponge flat side up, and put a handful of bran on it, then quickly turn against the wall, and rub the wall gently and carefully with it; then repeat the operation. Hold a large pan or spread down a drip cloth to catch the bran as it falls, but never use the same bran twice. Still another way is to use Canton flannel. The best way to use it is to get, say, 3 yards, and then cut it in strips lengthwise, a foot wide; then roll a strip around a stick 10 inches long, so as to have the ends of the stick covered. Have the stick not more than an inch in diameter. Have the cottonous or nap side of the cloth outside. Commence and wipe, when the cloth gets soiled unroll that much and make a roll of it, wipe again and repeat. Have your second or soiled roll turn in toward the first or clean roll. Hold them together with thumb and fingers. In this way you can change places on the cloth when soiled and roll the soiled place in, which will enable you to use the whole face of the cloth. To take out a grease spot requires careful manipulation. First, take several thicknesses of brown wrapping paper and make a pad, place it against the grease spot, and hold a hot flatiron against it, to draw out the grease, which will soak into the brown paper. Be careful to have enough layers of brown paper to keep the iron from scorching or discoloring the wall paper. If the first application does not take out nearly all the grease, repeat with clean brown paper or a blotting pad. Then take an ounce vial of washed sulphuric ether and a soft, fine, clean sponge, and sponge the spot carefully until all the grease disappears. Do not wipe the place with the sponge and ether, but dab the sponge carefully against the place. A small quantity of ether is advised, as it is very inflammable.

Harness Oil.—

Oil of turpentine	8	ounces.
Beeswax	2	"
Prussian blue	¼	"
Lampblack	¼	"

Melt the wax in an iron ladle, add the tu[illegible] and then the finely powdered Prussian b[illegible] black, and thin with neatsfoot oil.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Emeralds in Colombia.—Until very recently, emeralds were a drug in the market of Bogotá, says C. B. Hart, Minister, Bogotá. One who desired to buy them had only to wait and have them brought to him. The famous Muzo mine, which has produced emeralds of great value and in large quantities, lies near Bogotá, and the people of this city have long been familiar with its products. This mine is operated by a French company, which insists that for the past year or so it has found almost no emeralds. However, from this source or from others crude emeralds have continued to come into Bogotá. Of the cut stones, set and unset, there has been an abundance in the market. Hard times have compelled many persons to offer for sale their highly prized heirlooms, and these have been obtainable as a rule at very low prices.

About ten days ago an emerald craze seized upon Bogotá. The jewelry stores and all other establishments where emeralds are dealt in were besieged by persons who wished to buy, and by others who wished to sell; and for the same reason, men and women crowded the streets, standing in the roadway as well as on the sidewalk, some displaying their emeralds and others their money. A jewelry establishment located on the most prominent corner in Bogotá was compelled to ask the police to drive the crowd away.

As the news spread outside of Bogotá, emerald owners began to rush in. This swelled the throng and sent the fever up several degrees. Sales were made right and left, at prices hitherto unheard of in this market. Persons who had not thought of selling, tempted by the wild rush to buy, brought out their emeralds and began trading. Nobody could explain the real cause of the excitement, and many are now beginning to realize that it was without real cause. About five days ago the fever reached its height, and has since been declining. While it lasted emeralds sold on a gold basis, at about three times their value in this market just before the excitement began. It is estimated that up to this time about 4,000,000 pesos have changed hands as the result of the furor.

The crowd has almost disappeared from the streets, and many buyers who went in on the flood tide find themselves with emeralds that will not bring the price they paid for them. Others, also inexperienced, have more or less excellent imitations as souvenirs of this extraordinary movement. It does not appear that the expert dealers have bought so extravagantly as the general public, and yet it is believed that some of these have far overreached themselves.

The only approach to an explanation for this craze is that a Bogotá dealer who went to Paris recently, on his return to this city began to buy emeralds at higher prices than had been ruling in the market. This seems to have started it. Some of the experts say that this dealer drew out of the market long before prices reached their height, and that he did so because emeralds were selling in Bogotá for more than they would bring in Europe.

Pumps in Cape Colony.—I have already called the attention of manufacturers of well drills, pumps and windmills to the demand for wells and pumping apparatus by the farmers of this country, says Consul-General J. G. Stowe, of Cape Town,* and I now present some statistics on the subject. In 1890, the first boring was made in this country by a diamond drill for water, and from that year to the present time the government has carried on the work, owning the drills and charging a less price than the farmer would have to pay if he owned the drill. It is estimated that a successful bore made by the government cost the farmer £19 ($92.46), against £29 ($141.13) when he does the work himself, and more successful results have been obtained. The result has been, for 1898 alone, to add 3,000,000 gallons to the daily water supply of this colony.

The government is still inundated with applications, and with the present supply of drills the work can not be done fast enough. It is expected that by the time the applications now on hand are taken care of, 1,000 more will be waiting. It is an established fact that there is an excellent supply of underground water almost all over the colony, at a reasonable depth below the surface. The rainfall of this colony is not greatly inferior to that of other countries. Several dams are being built, and in one over 1,400,000,000 gallons have passed through the sluices, and there is still sufficient water to fill the dam when completed.

The wells being bored will need pumping appliances of various kinds, and windmills appear to be the most inexpensive; those just arriving have been readily sold. The government may yet assist the farmers in purchasing such appliances.

In 1898 there were 19 government water drills at work; 306 applicants were served and 547 applied; 367 bore holes, 10 feet or more deep, were made; 26,573 feet were bored, the drills (19) making an average of 1,399 feet each; 258 holes produced 1,000 gallons per day and upward; and the estimated total yield of water per diem was 3,000,000 gallons. In 106 holes, water flowed to the surface to the extent of 783,000 gallons per diem; and by pumping, a supply of 2,217,000 gallons can be obtained from the other 219 holes.

Recently, a large steam-power drill was purchased in England for the purpose of making a trial deep-bore hole. The first boring, when between 120 and 171 feet from the surface, struck a supply of water yielding 21,400 gallons per diem, and a steam pump failed to lower it. Another bore has been made to the depth of 1,504 feet and discontinued, owing to the exhaustion of the special fund set apart by the government.

Agricultural Possibilities in the Yukon Territory.—Under date of September 6, 1899, Consul McCook, of Dawson City, transmits the following statement, prepared by Messrs. Acklin & Morley, of that place, on the agricultural possibilities in the Yukon territory:

MESSRS. ACKLIN & MORLEY TO CONSUL MCCOOK.

ARCTIC GARDENS, Dawson.

SIR: In submitting to you our views and experiences of what can be grown successfully here, we do so hoping that it may prove of benefit to your department and to the people at large. Experiments were commenced in 1898 by Mr. Acklin and proved successful with the following vegetables, viz.: Radishes, lettuce, carrots, turnips, peas, rutabagas, and Siberian kale. For the season of 1899 we have tried both flowers and vegetables, and also some wheat, barley, and oats, which have, taken as a whole, proved very successful. We give you a list of the varieties of flowers, vegetables and grain grown, the dates of sowing, planting and maturing of crop, as near as possible.

SOWN IN CABIN IN BOXES, APRIL 5.

Flowers.—Pansies, China pinks, asters, cornflower, centaureas in three varieties, Stocks giant perfection, annual chrysanthemums, dahlias, nasturtiums, sweet peas, mignonette, Gabrielle calendulas, ærocliniums, and helichrysums, Shirley poppies.

Vegetables.—Leeks, lettuce, parsley and celery, cauliflower-cabbage.

The foregoing plants were transplanted to the open ground from May 10 to June 1, inclusive. The flowers commenced blooming very quickly; the first pansies were picked July 4; Shirley poppies, June 27; the remaining flowers bloomed in profusion by the second week of July, excepting the dahlias, which from all appearances will only make tubers this year and be in good shape for the season of 1900.

PLANTED IN THE OPEN.

On May 3 we sowed fifteen varieties of sweet peas in the open ground; they were in bloom in seven weeks from the time of sowing.

Vegetables were sown outside on the following dates. We have not kept the exact date when we commenced marketing the different varieties, but it is sufficient to say that they grow as well and mature as quickly as in Vermont, Minnesota, and other Northern States.

April 24.—Radishes.

April 26.—Peas (American Wonder), prickly spinach, English mustard, Scotch kale, lettuce of all varieties.

May 10.—Carrots (Danvers half-long, and Oxheart), turnips (Flat Dutch).

May 24.—Beans (Broad Windsor, Golden wax, Wardwell's Kidney wax, etc.); peas (Little Gem, American Wonder, etc.); parsnips, rhubarb (Victoria and Stott's Mammoth), cucumber (Boston Market, White Spine), onions (Danvers, Yellow, Queen, etc.)

May 27.—Transplanted cabbage, leeks, cauliflower and parsley.

We make frequent sowings of radishes and lettuce, as they mature more quickly than any other vegetables.

The following varieties of cereals have been experimented with from samples from the Dominion experimental station at Ottawa, and the results go to prove that all the cereal grains, such as wheat, rye, oats and barley, can be grown here and the country made self-supporting.

April 26.—Oats, three kinds; harvested August 17 and 28.

May 22.—Barley, six kinds; harvested August 17 and 28.

May 22.—Wheat, five varieties; harvested August 28.

SUMMARY.

From our observations of the climate here, we see no reason why the small fruits, as strawberries, raspberries, blackberries, currants, and gooseberries, could not be cultivated profitably, as they are growing wild in the surrounding country.

Timothy, redtop, and several other grasses suitable for hay, also grow wild and as luxuriant as in any part of the United States.

In the floral line, we have as pretty wild flowers, especially roses, as can be seen in any Northern climate.

The duration of the season suited to vegetation is approximately five months in the lowlands and islands along the rivers, and two to four weeks longer on the hillsides with southern exposure.

Japanese Market for Wood Pulp.—Consul Bordewich, of Christiania, under date of August 25, 1899, writes: I inclose translation of a cutting from a Christiania paper of recent date, from which it will be observed that the Norwegian manufacturers of wood pulp are advised, by a very well-posted authority, that Japan is likely to become a good market for their product. It will also be observed that competition from America is feared. It appears to me that American wood pulp from the Pacific Coast should be able to control the Japanese market.

A NEW MARKET FOR OUR WOOD PULP.

[From the Morgenposten, Christiania, August 22, 1899.]

In a report from Minister Gude regarding his mission to China and Japan, he states that in the last-mentioned country there might be found a considerable market for our exports of wood pulp for paper manufacture.

The minister believes that our enterprising exporters of wood pulp might be able to accomplish something in this branch there, as it still is new and but little worked. But all now depends upon getting ahead of the Americans.

In the statistics for 1895, however, he has not found wood pulp specified as an article of import from the United States. On the other hand, he discovered several orders for wood pulp to Norwegian firms, so he reasons that the market could easily be secured and increased, if our exporters would make efforts in this direction.

In Japan, both common pulp and chemical pulp is needed; both kinds are used even now in large quantities by the largest paper mill there. The Japanese, with their great facility for imitation, have, it seems, also become desirous of manufacturing a different and finer paper than the soft and porous article which they have so far made from a pulp consisting of rice straw, papyrus, bark, etc., the same as is used in China. But for this, European wood pulp is needed, as the attempts to make wood pulp from native Japanese wood have not met with success.

American Wheat for the Manufacture of Macaroni.—The Department of State has received from the Department of Agriculture a letter addressed to it by Mr. James B. Simpson, of Dallas, Tex., requesting its assistance in forwarding samples of Texas wheat to the United States consul at Lyons, to be tested as to its fitness for use by French manufacturers of edible paste. Mr. Simpson's letter was referred to the Bureau of Foreign Commerce. It is accompanied by another letter from him, which was printed in a Texas newspaper, in which he says:

"The Department of State favors me by sending to my address reports from its consuls.

"In the volume of reports for July last, I observed that Mr. John C. Covert, United States consul at Lyons, France, reports an enormous increase in the manufacture and consumption of macaroni and like edible pastes, not only in France, Italy, Spain, and Switzerland, but all over the globe.*

"This gentleman states in an interesting monograph upon this subject that a hard wheat containing a large percentage of gluten and relatively small percentage of starch is required, and that the millers and bakers of France are finding out that bread is much improved by putting into it a larger amount of gluten than is found in the French wheat, or in the ordinary starchy wheats from America.

"Mr. Covert states that the estimated output in France alone of these edible pastes approximates now 170,000,000 pounds, and is surely destined to a vaster increase. This estimate, of course, does not include the manufacture and output of macaroni in Italy, Spain, or Switzerland, where the demand for hard, glutinous wheats is yearly increasing, the consul stating that a number of establishments are constantly employed in making large hydraulic presses for the production of these pastes, not only in France, but in Italy, Germany, and Switzerland.

"Believing that the wheat exactly adapted to the making of macaroni and similar edible pastes is that hard, flinty, glutinous wheat called in North Texas the Nicaragua wheat and seemingly almost indigenous to our black lands and warm climate; and knowing that there never was a failure in the growth of this grain in North Texas, and that such is its wonderful productiveness that an average of fifty bushels to the acre is made, I took occasion to write these facts to Mr. Covert.

"Mr. Covert became deeply interested in my letter, realizing at once the great possibilities to North Texas, and referred it to M. Edouard W. Sorrell, a distinguished chemist, of Chabeuil, France. That gentleman wrote in reply a letter of some six pages (too long to insert here), but substantially stating that if we could grow this character of wheat a practically limitless demand existed for it in Europe, and that it could readily be shipped through Galveston.

"M. Sorrell further suggested that he be sent two bushels of this Texas-grown wheat for chemical analysis, which he would gladly make, and if it was as anticipated not only could France take all produced in North Texas, but that capital would quickly come from France to Texas, putting up here establishments with a yearly output of $18,000,000.

"It is proper for me to observe in this connection that Consul Covert suggests that if this wheat prove suitable to edible paste requirements, Texas should have a quantity made into macaroni and exhibited at the coming exposition at Paris; and he would himself, in the interest of Texas and the immense possibilities growing out of the production of this grain, devote a month of his time to bringing the matter before the milling and macaroni trade of France.

"M. Sorrell also is pleased to say in his letter to Consul Covert: 'I would be happy to have you tell the Dallas people that I will be glad to help them.'

"Since I have taken up this grain matter, I have spoken with several farmers of Dallas county, who are unanimous in their opinion that we can grow to perfection in North Texas just the wheat required by this great European industry, and so satisfactory would be found the profits, that our black lands would advance quickly from 25 per cent. to 50 per cent. in value.

"If I can be furnished the two bushels of wheat required, I will see that it is transmitted to our consul at Lyons."

The wheat will be forwarded to the consul at Lyons for the proposed analysis by M. Sorrell.

Proposed Steamship Line from Spain to Peru.—The secretary of legation at Lima, Mr. Neill, under date of September 9, 1899, sends an article from El Comercio of that city, treating of the proposed line of steamers between Peru and Spain. A representative of the Transatlantic Steamship Company, of Barcelona, is now in Lima. This company, it appears, has just made a contract with the Chilean government to give a monthly service to Valparaiso in return for a moderate subvention. Low freight rates will be charged on cargo for Chilean ports. If the voyages of the steamers were extended from Valparaiso to Callao, says the article, it would benefit not only the Peruvian-Chilean trade, but also the trade of Peru with Spain.

German-Guatemalan Trademark Convention.—Consul-General Beaupré, of Guatemala, under date of August 22, 1899, sends translation of an agreement recently celebrated between the governments of Guatemala and Germany, according to which merchants residing in either country shall enjoy in the other the same protection and privileges in regard to trademarks as native merchants.

* See Advance Sheets No. 244 (October 12, 1898); Consular Reports No. 218 (November, 1898).

* Consul Covert's report was printed in Consular Reports No. 226 (July, 1899), pages 468-470; also in Advance Sheets No. 428 (May 29, 1899).

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

EXPERIMENTS WITH HIGH-FREQUENCY CURRENTS AT THE CHARLOTTENBURG TECHNICAL SCHOOL.

IN the collection of instruments of the electro-technical laboratory of the Royal Technical High School of Charlottenburg is a most complete apparatus for experimenting with high-frequency alternating currents so diligently studied by Nikola Tesla. Before describing the nature of these experiments a few words of explanation are perhaps necessary.

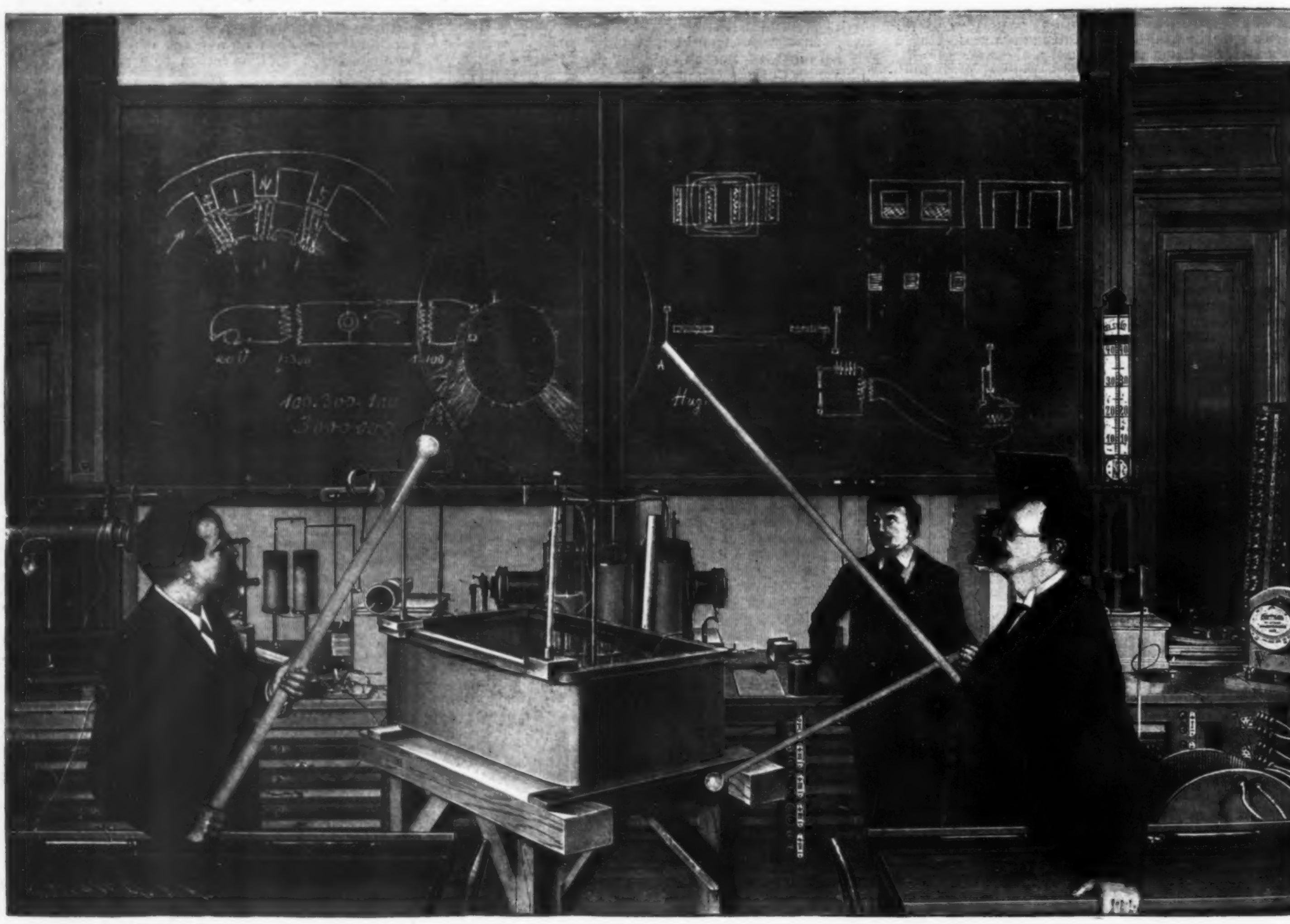
An alternating current is one whose direction is constantly changing. On the electric light circuits in common use the changes occur about fifty times in a second. Large as this number may appear, it is nevertheless exceedingly small when compared with the high frequencies obtained by Tesla. He has succeeded in changing the direction of his current more than 100,000 times per second. This high frequency can be obtained by charging the well-known Leyden jars with an ordinary alternating current and then discharging them to produce sparks.

In order to perform experiments similar to those of Tesla, the tension of the current should be as high as possible. By means of a transformer the ordinary alternating current with its tension of 100 volts can be changed into a current with a tension of 30,000 volts. This current is then conducted to Leyden jars and its tension increased to 3,000,000 volts by an oil-transformer.

In the background of our illustration, taken from Für Alle Welt, may be seen the first transformer, in front of which stand the Leyden jars; in the foreground is a large earthen tank filled with oil, constituting the oil-transformer.

Despite its great tension a high-frequency current is not dangerous to organic life. Between the poles emerging from the oil and the human body large sparks may pass without injury; while an ordinary alternating current with a tension of 1,000 volts is deadly.

Another peculiarity of the high-frequency current is the great radiating power of the terminals. Between the poles protruding from the oil and represented in the illustration in the form of two curved wires, the atmosphere becomes luminous. The vacuum tubes, such as those held in the hands of the experimenters, can be illuminated without any wire connections whatever. It is this method of illumination by vacuum tubes which Tesla claims will supplant our present system of lighting. It is his intention, furthermore, to render the upper regions of the atmosphere luminous by means of suitable apparatus. He also dreams of dispensing with the wires so necessary at present in the electrical transmission of power.



EXPERIMENTING WITH HIGH-FREQUENCY CURRENTS AT THE CHARLOTTENBURG TECHNICAL SCHOOL.

FACTS ABOUT STORAGE BATTERIES.

By ISAIAH L. ROBERTS.

PROBABLY there is no device now commonly used by mankind which is shrouded in so much mystery as to its internal operation as the common storage battery. The average intelligent citizen knows that a steam engine is operated by the driving of a piston back and forth in a cylinder by the pressure of the steam behind it, or that a windmill is caused to operate by the sails or blades' being pushed by the force of the wind which strikes them; but the operations going on in the storage battery, both in charging and discharging, are far more subtle than any operation in mechanics. For the above reasons a large amount of capital and time has been wasted in doing the wrong thing, when a little real knowledge of the underlying principles involved would have saved much of both.

In looking over the history of the storage battery from Planté until to-day, one is surprised at the amount of work done and the small advance made. Numerous patents have been obtained, and in many of them great hopes were placed that at last the ideal battery had been discovered. Finally, however, after much testing by actual practice, the fatal defect appeared, and the interested ones went their ways, having in most cases added something to their store of knowledge if not to their bank accounts. The reason of this is that the storage battery is almost wholly an electro-chemical problem, and has but little mechanics in it, while the efforts have been made almost entirely on structural lines. To prove this it is necessary only to take copies of the patents beginning with Faure's famous discovery that oxide of lead could be mechanically applied to the surface of the lead electrodes instead of "forming" it on them, as was the case with the Planté type. This was the first mechanical mistake, but it was followed by a host of others in rapid succession, each worse than the other, if possible. Few took the pains to investigate what caused the Planté cell to store electricity, but it was assumed generally that all that was necessary was to get oxide on to the positive plate and reduced lead on the negative plate somehow, without regard to the laws of electrochemistry.

Without going into names, dates and places, I may say that it was after awhile found that the old Planté battery was better than the best pasted cells. Then the question as to why came up, and investigation showed that want of contact—"electrical contact," that first puzzle to the beginner in the application of electricity, good connection of one conductor with another—was the trouble. Electricity of the tension used in storage batteries will not pass over a space or through a non-conductor, however thin. The novice in electricity is often much surprised when he twists his half-cleaned wires together (to him) in the most reasonable manner, and attaches the ends to his bell or pea lamp, to find no ring or light. The first lesson in electricity is to have clean connectors and terminals; otherwise, poor or no contact. Now, this is no less necessary in the construction of a storage battery plate than it is in fine wiring. When oxide of lead is merely painted or laid against a sheet of lead and held there even under a slight pressure, it is all useless except those molecules which actually are in contact with the lead plate, because the oxide of lead when applied is a non-conductor and as such is not only of no use unless it can be made "active," but is in the way.

When this was found out, many mechanical means, some of them quite ingenious, were devised for forcing the oxide of lead into holes or convolutions in the plates. Some of these had slight merit, in that they got much more surface for the contact lead oxide, but another difficulty arose. It was found that the low oxides of lead used in the said holes or convolutions, when formed into peroxide, as it must be in order to become "active," occupied a considerably larger space than before and caused the plates to expand and "buckle," especially the latter if severely or rapidly charged.

It became necessary to get some hard substance to prevent this buckling which could be substituted for the lead. This was found in an alloy of antimony and lead. The antimony not being harmful, it gave hardness and rigidity to the plate. The oxides could be put into holes and held there more forcibly. This form of plate is now generally considered the best mechanical device up to date.

Various methods of etching by electrolysis or chemical methods where lead is used have been tried whereby the oxides might be formed more quickly than by the Planté method. Some of them have been more or less successful, and one is claimed by some experts to be better than the filling in the holes or convolutions mechanically. However this may be, the quantity of energy that any lead storage battery will receive or yield depends directly on the amount of conductive crystalline structural peroxide of lead that is in electrical contact with the positive element. I have said nothing so far about the negative plate or element. This element is not so much of an offender, because the oxide on it is much more easily reduced, and once reduced gives but little trouble, whether in the Planté or Faure type, as oxide, when reduced to the metallic state, does not expand and adheres well. However, if the battery be too rapidly discharged, buckling, where lead plates are used, will occur, owing to the more rapid oxidation of the plate when nearer its positive mate in one point than another, as the current seeks the lines of least resistance, which are in a storage battery the shortest distance between the plates at any point.

Having now outlined the principal mechanical points of the storage battery, we will take notice of what goes on chemically.

If we now take two plates of antimony-lead alloy and make as many holes in them as we can and yet leave a good margin of strength, and fill these holes with oxide, chloride or sulphate of lead, either under high pressure or by fusing them first into button form, and then pressing these buttons into the holes, we have like conditions on both plates. If oxide of lead is used, we must place these plates in an electrolyte of sulphuric acid and water and pass a current of electricity through the plates and the solution. On one of the plates oxygen gas will be evolved from the water and on the other hydrogen. The oxygen will be absorbed by the sub-oxide of lead, which will be converted into peroxide of lead, and this plate becomes the positive in the storage cell, while the hydrogen evolved from the other plate takes the oxygen from the oxide on it and reduces it to the metallic condition, and this plate becomes the negative.

If a salt of lead is used to fill the holes, say chloride of lead, the chlorine from the chloride must be removed by electrolysis completely from both plates before using in a storage cell. After the removal of the chlorine the plates are then put into the sulphuric acid

and both are treated by electrolysis, as was described in the case of the use of oxides, and with the same results.

We will assume that the positive plate is charged with one of the lower oxides of lead—say red lead, Pb_3O_4—and the negative with litharge, PbO. As the positive plate is mechanically charged with lead oxidized up to the point of Pb_3O_4, electric storage begins from this point. Now, as soon as there is one molecule of peroxide—PbO_2—formed on the positive plate, storage has begun and goes on until as much of the lower oxide is converted into peroxide as is possible, and there storage stops and nothing further can be accomplished by continuing the charging current.

We have now more or less of the oxide on the positive plate converted into the peroxide, while on the negative plate the low oxide is reduced to lead in a finely divided but coherent spongy metal. The battery is now charged. If we now connect this battery to some conductor and close the circuit through some work to be done, as a lamp or motor, the oxygen in the peroxide in the positive plate begins to oxidize the reduced lead sponge on the negative plate by electrolysis, and in doing so yields a portion of the current which it required to force it into the peroxide molecule. This action will go on until all the spare oxygen in the peroxide is transferred to the negative plate and there forms sub-oxide—Pb_2O—and litharge—PbO—when the battery is discharged.

This can be repeated as often as desired. Unfortunately, however cunningly we may place the oxide into or onto the positive plate, we can never convert it all into the peroxide, because it is not a conductor to begin with, and therefore action must begin at the surface of the plate and work outward. Now, as even the peroxide is only a poor conductor compared to the metal plate, the first film next to the metal must act as a conductor to the next or adjacent layer of oxide molecules and cement them by good "electrical contact," and so on outward as far as this change can go, and, as I have before said, this cannot go to the outermost layer. In fact, it can only go a short distance from the metal plate. Now, if from any cause a portion of this layer of peroxide becomes detached by a jar or by gas being formed on the plate under it, as both frequently happen, it is then worse than useless, because it remains peroxide. Its oxygen is not then available for transfer, as its contact with the plate is lost, and it frequently falls to the bottom of the containing jar or cell and may act as a conductor and thus "short circuit" the cell and thus render it useless until removed. Hence, it is necessary to raise the plates a short distance from the bottom of the cell, so as to prevent these detached pieces from coming in contact with the plates. Where batteries are used roughly, as is the case in all portable batteries, especially such as are in use in automobiles, only the amount of oxide which can be made available should be used on the plates. It is unfortunate also that in discharging a lead storage battery we can never get back all the energy we put into it, owing to an inherent difficulty which the law of chemical affinity enjoins, and that is this: We must use enough energy to take away the oxygen from one molecule of sub-oxide of lead on the negative plate, which tends to keep all it has because it has a strong affinity for what it has, and it holds on with a certain force. Having robbed the sub-oxide, we force a satisfied molecule of a higher lead oxide on the positive plate to take another atom against its will, and it resists this with a certain force. The combined resistance of these molecules in this forceful transference amounts to about one-half a volt. Now, after forcing this oxygen atom to take its place in a molecule of peroxide, it will go back to its old alliance, but will not pay back one cent of its cost of transportation. This means that we must use about two and one-half volts to make this transference in charging and get back less than two volts in discharging. But if the peroxide gets detached, we have lost all the energy the amount detached contains.

It is also unfortunate that so far lead is the only metal that can be used for storage purposes. It is a comparatively heavy metal, and while only slightly soluble in sulphuric acid, it forms quite readily sulphate of lead from certain of its oxides, hence in the management of storage cells great care should be exercised in discharging the battery, for if too fully discharged, certain oxides formed will unite with the acid and form sulphate, especially if the cell is allowed to stand unused for a short time. This is termed "sulphating." Hence, if a cell is discharged, it should be either immediately charged again or the acid be removed and plates washed with clean water.

As previously shown, only a portion of the oxide on the positive plate can be made available, and of the total amount of oxygen contained in the peroxide—PbO_2—we can only use one atom from two molecules, making a new molecule out of the two, Pb_2O_3, which will not yield any more, as it is then satisfied. Hence the great weight of battery necessary to contain a small amount of energy.

Electricians are often asked how much energy is contained in a fully charged cell of a certain weight and size. This is about as intelligent a question as "How big is a piece of chalk?" For instance, if we wish to construct a light-weight cell and yet get the same yield per square foot of submerged plate, we must do that at the expense of the metal in the plate, and not by using any less oxides on or in them, for the reasons just given. If we go far in this direction, we can get a battery which will show comparatively fine results on test, but will not be so durable, because the plates are thin and weak; and if lead plates are used, as is generally the case, each charge "bites" or oxidizes a little more of the positive plate (à la Planté) and will soon destroy the plate or weaken it too much for use. When such batteries are used, they are short-lived.

Hence the most successful use of the storage battery to-day is in central station work, where they can be made as large and strong as desired and set on strong foundations, where they are never moved or shaken. Here they have come fully up to the work required of them when that work was calculated by experienced battery men.

No great durability should be expected of a lead storage battery which is constructed to yield in effectual work day by day over four watt hours per pound of cell, solution, plates and connectors, and less than this is desirable for economical longevity. With lead we have started and seem to have ended, but I still believe that somewhere in the domain of chemistry there must be a better combination than the one described above.—The Horseless Age.

ELECTRIC PROPULSION AT TOURS.

A FEW months ago, the Compagnie Industrielle de Traction, in conjunction with M. De Brancion, made at Tours the first industrial application of the new Diatto system of superficial contacts with subterranean conductors. The cars of the tramway to which this system has been applied have not ceased since they were put in service to operate in a satisfactory manner.

The system of tramways of Tours is to comprise a series of city lines of a length of about seven miles and the suburban lines of Luynes, Saint Avertin, and Vouvray. The Diatto system will be installed in the interior of the city, and outside of the latter the overhead trolley will be used.

The generating works comprise at present four semi-tubular boilers constructed by MM. Bonnet, Spazin & Company, of Lyons. These have a heating surface of 1,775 square feet, and each is capable of furnishing 4,400 pounds of steam per hour. The steam engines, three in number, were furnished by MM. Piquet & Company, of Lyons. They are single cylinder condensation motors of 300 horse power, and each of them drives, through a belt, a dynamo of 200 kilowatts at 550 volts. The current is furnished by cables laid directly in the ground, and from which start at every 16 feet conductors for supplying the superficial contacts. Upon the track, between rails, as shown in Fig. 2, are arranged, here and there, blocks of asphaltum, the top of which is flush with the surface and carries in the center a slightly projecting piece of metal, *E*. In the interior of the block there is a rod connected through the derivation, *I* (Fig. 3), with the cable, *J*, coming from the works. The car is provided with electro-magnets, *A*, which magnetize the pieces, *B*, *C*, and *D*. These latter, upon sliding over the metallic piece, cause the attraction in the interior of a rod, *P*, which establishes an electric communication of the bar, *B*, of the car with the current entering through the cable, *J*. The blocks are by this means put in connection with the conductor only at the precise moment at which the bar of the car is above one of them; and the current would be broken as soon as the car had got beyond the contact, were not the blocks arranged at such a distance apart as to prevent it and thus make the current continuous.

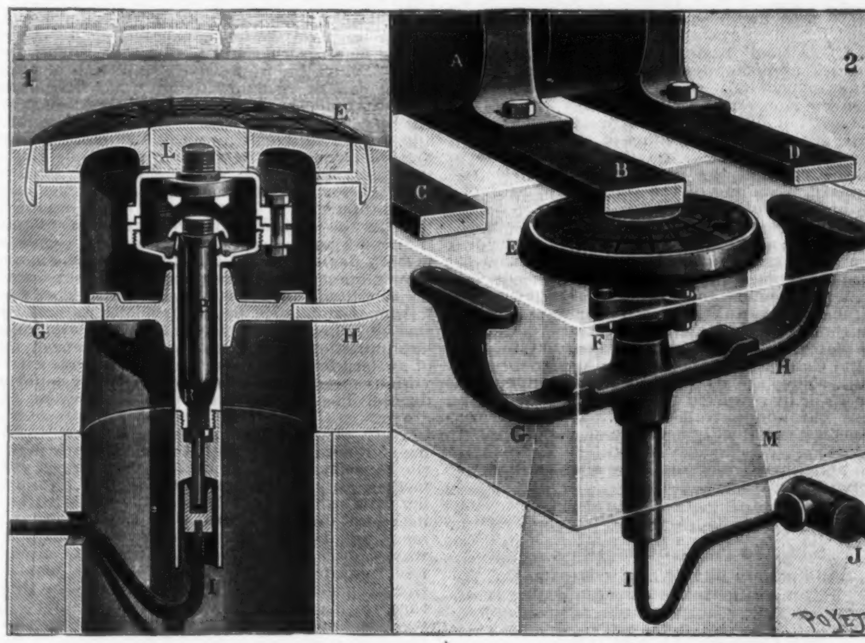


FIG. 3.—DETAILS OF THE DIATTO SYSTEM OF CONTACT.

1. Vertical section of the contact block 2. General view of the block with the magnetized bar above.

The asphaltum blocks (one of which is represented as transparent in Fig. 3, No. 2) are hollow and communicate with the earth through a pipe (Fig. 3, No. 2). At the upper part there is a movable cover, *E*, of antimagnetic metal that carries in the center a soft iron axis, *L*. Just beneath there is a cast iron crosspiece, *G H*, with upturned wings, which allows of the passage through the center of an ebonite receptacle filled with mercury. Into the lower part of the latter, at *R*, is screwed a copper plug that carries a small copper rod which enters a cup filled with mercury. This latter is connected with the cable, *I*, that branches from the cable coming from the works. In the mercury that fills the ebonite receptacle floats the iron rod, *P*, the weight of which is sensibly balanced by the thrust of the liquid. The head of this rod carries a piece of pure graphite carbon, very hard and homogeneous, in the form of a truncated cone. The iron axis, *L*, carries also a piece of the same kind of carbon hollowed out

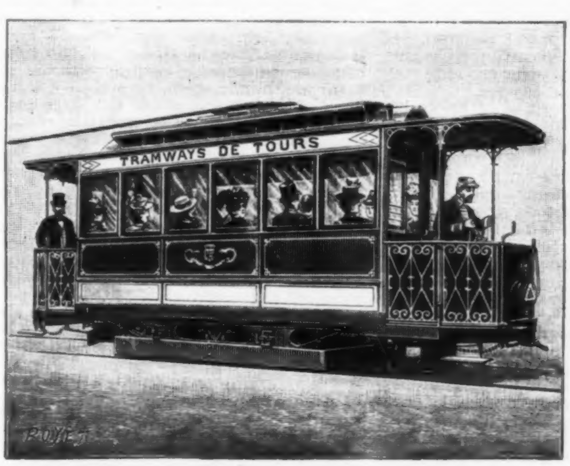


FIG. 1.—THE DIATTO CAR, COMBINING THE TROLLEY AND UNDERGROUND ELECTRIC SYSTEM.

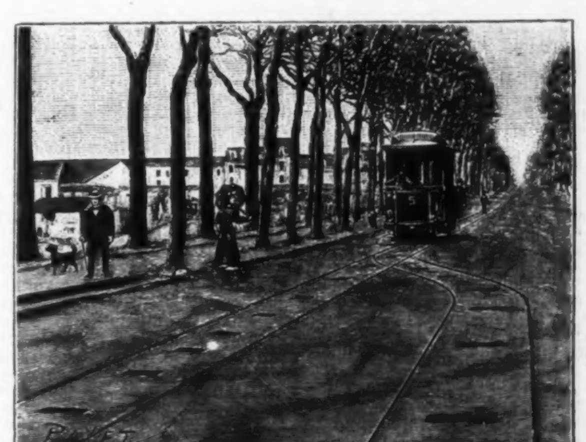


FIG. 2.—THE DIATTO SYSTEM, WITH THE SUPERFICIAL CONTACTS BETWEEN THE TRACKS FOR THE UNDERGROUND TROLLEY.

in the form of a cone of which the angle is equal to that of the head of the rod, *P*. The two pieces therefore fit into each other perfectly and give an excellent contact. The part in which the contact takes place is, as may be seen from the figure, inclosed in a casing. The magnetized bars, *B*, *C*, and *D*, that are carried by the car, merit a particular description. Between these bars are mounted horizontal electro-magnets, *A*, which give a north polarity to the central bar, *B*, and a south polarity to the external bars, *C* and *D*. The magnetic fields are then established on the one side by the bar, *B*, the rod, *P*, the wing, *G*, and the bar, *C*, and on the other side by the bar, *B*, the rod, *P*, the wing, *H*, and the bar, *D*, and the rod, *P*, is attracted.

Each electro-magnet is provided with two distinct windings, one traversed by the current that supplies the motor during the running, and the other continuously traversed by the current furnished by a small battery of accumulators giving 5 amperes at 30 volts. At the moment of starting, it is the current derived from this small battery that magnetizes the electro-magnets and lifts the rod, *P*. The latter is attracted and immediately closes the current of the works upon the motor of the car.

The formation of a permanent arc or of any sparks is prevented at the points of contact of the carbons as a consequence of the good quality of the latter. Moreover, the back of the bar is raised in order to further assure the holding of the rod and to prevent an abrupt breakage of the current.

The blocks of asphalt are so arranged that water cannot enter them at any time. The return of the current to the works takes place through the rails. Let us add that the replacing of a defective block can be effected in a few seconds, as experiment has shown.

The automobile cars (Fig. 1) accommodate thirty-six passengers, twenty seated and sixteen standing upon the platforms. They were constructed in the shops of the Compagnie Générale de Construction of Saint Denis. They are arranged for running upon the Diatto tracks or by overhead trolley, and carry both a magnetized bar and a trolley pole. The necessary communications are quickly made by means of special commutators.

For the above particulars and the illustrations we are indebted to La Nature.

[Continued from SUPPLEMENT, No. 1246, page 19973.]

MECHANICAL SCIENCE.

OPENING ADDRESS BY SIR WILLIAM WHITE, K.C.B., LL.D., F.R.S., PRESIDENT OF THE MECHANICAL SCIENCE SECTION, BRITISH ASSOCIATION.

THE PARSONS TURBOMOTOR.

THE steam turbomotor introduced by Mr. Charles Parsons is to be described by the inventor during these meetings; but it is impossible for me to pass it over in this review without a brief notice. This rotary engine, with its very high rate of revolution, reduces the weights of machinery, shafting, and propellers greatly below the weight required in the quickest-running engines of the reciprocating type. This reduction in the proportion of weight to power carries with it, of course, the possibility of higher speed in a vessel of given dimensions; and when large powers are employed, the absolute gain is very great. An illustration of this has been given by Mr. Parsons in the "Turbinia." That remarkable vessel is 100 feet long and of 44½ tons displacement, but she has attained 33 to 34 knots in short runs. There are three shafts, each carrying three screw propellers, each shaft driven by a steam turbine making over 2,000 revolutions at full speed, when more than 2,000 horse power is developed. A water tube boiler of special design supplies steam of 175 pounds pressure, and is exceptionally light for the steam produced, being highly forced. The whole weight of machinery and boilers is 22 tons; in other words, about 100 horse power (indicated) is produced for each ton weight of propelling apparatus. This is rather more than twice the proportion of power to weight as compared with the lightest machinery and boilers fitted in torpedo boats and destroyers. It will be noted that in the "Turbinia," as in the destroyers, about half the total weight is devoted to propelling apparatus; and in both instances the load carried is relatively small. The secret of the extraordinary speed is to be found in the extreme lightness of propelling apparatus and small load.

No doubt in the "Turbinia" lightness has been pushed further than it would be in vessels of larger size and greater power. In such vessels a lower rate of revolution would probably be accepted, additional motors would be fitted for maneuvering and going astern, boilers of relatively greater weight would be adopted and other changes made. But, after making ample allowance for all such increases in weight, it is unquestionable that considerable economies must be possible with rotary engines. Two other vessels of the destroyer type with turbomotors (one for the Royal Navy) are now approaching completion. Their trials will be of great interest, as they will furnish a direct comparison with vessels of similar size and form fitted with similar boilers and driven by reciprocating engines.

On the side of coal consumption, Mr. Parsons claims at least equality with the best triple expansion engines. Into the other advantages attending the use of rotary engines it is not necessary now to enter.

Reference must be made, however, to one matter in which Mr. Parsons has done valuable and original work. In torpedo vessels of high speed the choice of the most efficient propellers has always been a matter of difficulty, and the solution of the problem has, in many instances, involved extensive experimental trials. By means of alterations in propellers alone, very large increases in speed have been effected; and even now there are difficulties to be faced. When Mr. Parsons adopted the extraordinary speed of revolution just named for the "Turbinia," he went far beyond all experience and precedent and had to face unknown conditions. He has found the solution, after much patient and original investigation, in the use of multiple screws of small diameter. His results in this direction are of general interest to all who have to deal with screw propulsion.

Such radical changes in propelling machinery as are involved in the adoption of turbomotors must necessarily be subjected to thorough test before they will be widely adopted. The experiment which the Admiralty are making is not on a small scale as regards power. Although it is made in a destroyer, about 10,000 horse power will probably be developed and a correspondingly high speed attained. It may well happen that from this experiment very far-reaching effects may follow. Mr. Parsons himself has prepared many designs illustrating various applications of the system to seagoing, cross-channel and special service vessels. Where shallowness of draught is unavoidable, the small diameter of the screws possible with the quick-running turbines is clearly an important matter.

COMPARISONS BETWEEN LARGE AND SMALL VESSELS.

It has been shown that the attainment of very high speeds by vessels of small size involves many conditions not applicable to large sea-going steamships. But it is equally true that in many ways the trials of small swift vessels constitute model experiments from which interesting information may be obtained as to what would be involved in driving ships of large size at speeds much exceeding any of which we have experience. When the progressive steam trials of such small vessels can be studied side by side with experiments made on models to determine their resistance at various speeds, then the fullest information is obtained and the best guide to progress secured. This advantage, as has been said, we owe to William Froude.

His contributions to the Reports of the British Association are classics in the literature of the resistance and propulsion of ships. In 1874 he practically exhausted the subject of frictional resistance so far as it is known; and his presidential address to this section in 1875 dealt fully and lucidly with the modern or stream-line theory of resistance. No doubt there would be advantage in extending Froude's experiments on frictional resistance to greater lengths and to ship-shaped forms. It is probable also that dynamometric determinations of the resistance experienced by ships of modern forms and considerable size, when towed at various speeds, would be of value if they could be conducted. These extensions of what Froude accomplished are not easily carried out; and in this country the pressure of work on shipbuilding for the Royal Navy has, for many years past, taxed to the utmost limits the capacity of the Admiralty experimental establishment so ably superintended by Mr. R. E. Froude, allowing little scope for purely scientific investigations, and making it difficult to deal with the numerous experiments incidental to the designs of actual ships. Norway, Holland, Russia, Italy, and the United States have equipped experimental establishments, while Germany and France are taking steps in that direction, we may hope for extensions of purely scientific work and additions to our knowledge. In this direction, however, I am bound to say that much might be done if experimental establishments capable of dealing with questions of a general nature relating to resistance and propulsion were added to the equipment of some of our universities and colleges. Engineering laboratories have been multiplied, but there is as yet no example of a modern experimental tank devoted to instruction and research.

It is impossible, and possibly is unnecessary, to attempt in this address any account of Froude's "scale of comparison" between ships and models at "corresponding speeds." But it may be of interest to give a few illustrations of the working of this method in the form of a contrast between a destroyer of 300 tons, 212 feet long, capable of steaming 30 knots an hour, and a vessel of similar form enlarged to 765 feet in length and 14,100 tons. The ratio of dimensions is here about 3·61 : 1; the ratio of displacements is 47 : 1; and the ratio of corresponding speeds is 1·9 : 1.

To 12 knots in the small vessel would correspond 22·8 knots in the large vessel, and the resistance experienced by the large vessel at 22·8 knots (neglecting a correction for friction) should be forty-seven times that of the small vessel at 12 knots. By experiment, this resistance for the small vessel was found to be 1·8 tons. Hence, for the large vessel at 22·8 knots the resistance should be 84·6 tons. This would correspond to an "effective horse power" of over 13,000, or about 26,000 indicated horse power. The frictional correction would reduce this to about 25,000 horse power, or about 1·8 horse power per ton. Now, turning to the destroyer, it is found experimentally that at 22·8 knots she experiences a resistance of about 11 tons, corresponding to an effective horse power of over 1,700 and an indicated horse power of about 3,000, say 10 horse power per ton, or nearly five and a half times the power per ton required in the larger vessel. This illustrates the economy of propulsion arising from increased dimensions.

Applying the same process to a speed of 30 knots in the large ship, the corresponding speed in the small ship is 15·8 knots. Her resistance at that speed is experimentally determined to be 3·5 tons, and the resistance of the large ship at 30 knots (neglecting frictional correction) is about 165 tons. The effective horse power of the large ship at 30 knots is, therefore, about 34,000, corresponding to 68,000 horse power indicated. Allowing for the frictional correction, this would drop to about 62,000 horse power, or 4·4 horse power per ton. For the destroyer at 30 knots the resistance is about 17½ tons, the effective horse power is 3,600, and the indicated horse power about 6,000, or 20 horse power per ton, nearly five times as great as the corresponding power for the large ship. But while the destroyer under her trial conditions actually reaches 30 knots, it is certain that in the large ship neither weight nor space could be found for machinery and boilers of the power required for 30 knots, and of the types usually adopted in large cruisers, in association with an adequate supply of fuel. The explanation of the methods by which the high speed is reached in the destroyer has already been given. Her propelling apparatus is about one-fourth as heavy in relation to its maximum power, and her load is only about one-third as great in relation to the displacement when compared with the corresponding features in a swift modern cruiser.

It will, of course, be understood that in practice, under existing conditions, a cruiser of 14,000 tons would not be made 765 feet long, but probably about 500 feet. The hypothetical cruiser has been introduced simply for purposes of comparison with the destroyer.

The earlier theories of resistance assumed that the resistance experienced by ships varied as the square of the speed. We now know that the frictional resistances of clean painted surfaces of considerable length vary as the 1·83 power of the speed. This seems a small difference, but it is sensible in its effects, causing a reduction of 32 per cent. at 10 knots, nearly 40 per cent. at 20 knots, and 42 per cent. at 25 knots. On the other hand, it is now known that the laws of variation of the residual or wave-making resistance may depart very widely from the law of the square of the speed, and it may be interesting to trace for the typical destroyer how the resistance actually varies.

Take first the total resistance. Up to 11 knots it varies nearly as the square of the speed; at 16 knots it has reached the cube; from 18 to 20 knots it varies as the 3·3 power. Then the index begins to diminish; at 22 knots it is 2·7; at 25 knots it has fallen to the square, and from thence to 30 knots it varies, practically, as does the frictional resistance.

The residual resistance varies as the square of the speed up to 11 knots, as the cube at 12¾ to 13 knots, as the fourth power about 14½ knots, and at a higher rate than the fifth power at 18 knots. Then the index begins to fall, reaching the square at 24 knots, and falling still lower at higher speeds.

It will be seen, therefore, that when this small vessel has been driven up to 24 or 25 knots by a large relative expenditure of power, further increments of speed are obtained with less proportionate additions to the power.

Passing from the destroyer to the cruiser of similar form, but of 14,100 tons, and once more applying the "scale of comparison," it will be seen that to 25 knots in the destroyer corresponds a speed of 47½ knots in the large vessel. In other words, the cruiser would not reach the condition where further increments of speed are obtained with comparatively moderate additions of power until she exceeded 47 knots, which is an impossible speed for such a vessel under existing conditions. The highest speeds which could be reached by the cruiser with propelling apparatus of the lightest type yet fitted in large sea-going ships would correspond to speeds in the destroyer for which the resistance is varying as the highest power of the speed. These are suggestive facts.

Frictional resistance, as is well known, is a most important matter in all classes of ships and at all speeds. Even in the typical destroyer this is so. At 12 knots the friction with clean painted bottoms represents 80 per cent. of the total resistance; at 16 knots, 70 per cent.; at 20 knots a little less than 50 per cent.; and at 30 knots, 45 per cent. If the coefficient of friction were doubled and the maximum power developed with equal efficiency, a loss of speed of fully 4 knots would result.

In the cruiser of similar form the friction represents 90 per cent. at 12 knots, 85 per cent. at 16 knots, nearly 80 per cent. at 20 knots, and over 70 per cent. at 23 knots. If the coefficient of friction were doubled at 23 knots and the corresponding power developed with equal efficiency, the loss of speed would approximate to 4 knots.

These illustrations only confirm general experience that clean bottoms are essential to economical propulsion and the maintenance of speed, and that frequent docking is necessary in vessels with bare iron or steel skins, which foul in a comparatively short time.

POSSIBILITIES OF FURTHER INCREASE IN SPEED.

From the facts above mentioned it is obvious that the increase in speed which has been effected is the result of many improvements, and has been accompanied by large additions to size, engine power and cost. These facts do not discourage the "inventor" who finds a favorite field of operation in schemes for attaining speeds of 50 to 60 knots at sea in vessels of moderate size. Sometimes the key to this remarkable advance is found in devices for reducing surface friction by the use of wonderful lubricants to be applied to the wetted surfaces of ships, or by interposing a layer of air between the skins of ships and the surrounding water, or other departures from ordinary practice. If these gentlemen would "condescend to figures," their estimates or guesses would be less sanguine. In many cases the proposals made would fail to produce any sensible reduction in resistance; in others, they would increase resistance.

Other proposals rest upon the idea that resistance may be largely reduced by adopting novel forms, departing widely from ordinary ship shapes. Very often small scale experiments, made in an unscientific and inaccurate manner, are adduced as proofs of the advantages claimed. In other instances mere assertion is thought sufficient. Ordinarily, no regard is had to other considerations, such as internal capacity, structural weight and strength, stability and seaworthiness. Most of these proposals do not merit serious consideration. Any which seem worth investigation can be dealt with simply and effectively by the method of model experiments. A striking example of this method will be found in the unusual form of a parliamentary paper (No. 313, of 1873), containing a report made by Mr. William Froude to the Admiralty. Those interested in the subject will find therein much matter of special interest in connection with the conditions attending abnormally high speeds. It must suffice now to say that ship-shaped forms are not likely to be superseded at present.

The most prolific "inventions" are those connected with supposed improvements in propellers. One constantly meets with schemes guaranteed by the proposers to give largely increased efficiency and corresponding additions to speed. Variations in the numbers and forms of screws or paddles, the use of jets of water or air expelled by special apparatus through suitable openings, the employment of explosives, imitations of the fins of fishes, and numberless other departures from established practice are constantly being proposed. As a rule, the "inventors" have no intimate knowledge of the subject they treat, which is confessedly one of great difficulty. When experiments are adduced in support of proposals, they are almost always found to be inconclusive and inaccurate. More or less mathematical demonstrations find favor with other inventors, but they are not more satisfactory than the experiments. An air of great precision commonly pervades the statements made as to possible increase in efficiency or speed. I have known cases where probable speeds with novel propellers have been estimated (or guessed) to the third place of decimals. In one such instance a trial was made with the new propeller, with the result that instead of a gain in efficiency there was

a serious loss of speed. Very few of the proposals made have merit enough to be subjected to trial. None of them can possibly give the benefits claimed.

It need hardly be added that in speaking thus of so-called "inventors" there is no suggestion that improvement has reached its limit, or that further discovery is not to be made. On the contrary, in regard to the forms of ships and propellers, continuous investigation is proceeding and successive advances are being made. From the nature of the case, however, the difficulties to be surmounted increase as speeds rise; and a thorough mastery of the past history and present condition of the problems of steamship design and propulsion is required as a preparation for fruitful work in the nature of further advance.

It would be idle to attempt any prediction as to the characteristic features of ocean navigation sixty years hence. Radical changes may well be made within that period. Confining attention to the immediate future, it seems probable that the lines of advance which I have endeavored to indicate will remain in use. Further reductions may be anticipated in the weight of propelling apparatus and fuel in proportion to the power developed; further savings in the weight of the hull, arising from the use of stronger materials and improved structural arrangements; improvements in form; and enlargement in dimensions. If greater draughts of water can be made possible, so much the better for carrying power and speed. For merchant vessels commercial considerations must govern the final decision; for warships, the needs of naval warfare will prevail. It is certain that scientific methods of procedure and the use of model experiments on ships and propellers will become of increased importance.

Already avenues for further progress are being opened. For example, the use of water-tube boilers in recent cruisers and battleships of the Royal Navy has resulted in saving one-third of the weight necessary with cylindrical boilers of the ordinary type to obtain the same power, with natural draught in the stokeholds. Differences of opinion prevail, no doubt, as to the policy of adopting particular types of water-tube boilers; but the weight of opinion is distinctly in favor of some type of water tube boiler in association with the high steam pressures now in use. Greater safety, quicker steam raising, and other advantages, as well as economy of weight, can thus be secured. Some types of water-tube boilers would give greater saving in weight than the particular type used in the foregoing comparison with cylindrical boilers.

Differences of opinion prevail also as to the upper limit of steam pressure which can with advantage be used, taking into account all the conditions in both engines and boilers. From the nature of the case, increases in pressure beyond the 160 to 180 pounds per square inch commonly reached with cylindrical boilers cannot have anything like the same effect upon economy of fuel as the corresponding increases have had, starting from a lower pressure. Some authorities do not favor any excess above 250 pounds per square inch on the boilers; others would go as high as 300 pounds, and some still higher.

Passing to the engine rooms, the use of higher steam pressures and greater rates of revolution may, and probably will, produce reductions in weight compared with power. The use of stronger materials, improved designs, better balance of the moving parts, and close attention to details, have tended in the same direction without sacrifice of strength. Necessarily, there must be a sufficient margin to secure both strength and endurance in the motive power of steamships. Existing arrangements are the outgrowth of large experience, and new departures must be carefully scrutinized.

The use of rotary engines, of which Mr. Parsons' turbo-motor is the leading example at present, gives the prospect of further economies of weight. Mr. Parsons is disposed to think that he could about halve the weights now required for the engines, shafting, and propellers of any Atlantic liner while securing proper strength and durability. If this could be done in association with the use of water-tube boilers, it would effect a revolution in the design of this class of vessel, permitting higher speeds to be reached without exceeding the dimensions of existing ships.

It does not seem probable that, with coal as the fuel, water-tube boilers will surpass in economy the cylindrical boilers now in use; and skilled stoking seems essential if water-tube boilers are to be equal to the other type in rate of coal consumption. The general principle holds good that as more perfect mechanical appliances are introduced, so more skilled and disciplined management is required in order that the full benefits may be obtained. In all steamship performance the "human factor" is of great importance, but its importance increases as the appliances become more complex. In engine rooms the fact has been recognized and the want met. There is no reason why it should not be similarly dealt with in the boiler rooms.

Liquid fuel is already substituted for coal in many steamships. When sufficient quantities can be obtained, it has many obvious advantages over coal, reducing greatly manual labor in embarking supplies, conveying it to the boilers and using it as fuel. Possibly its advocates have claimed for it greater economical advantages over coal than can be supported by the results of extended experiment. Even if the saving in weight for equal evaporation is put as low as thirty per cent. of the corresponding weight of coal, it would amount 1,000 tons on a first-class Atlantic liner. This saving might be utilized in greater power and higher speed, or in increased load. There would be a substantial saving on the stokehold staff. At present it does not appear that adequate supplies of liquid fuel are available. Competent authorities here and abroad are giving attention to this question and to the development of supplies. If the want can be met at prices justifying the use of liquid fuel, there will undoubtedly be a movement in that direction.

Stronger materials for the construction of hulls are already available. They are, however, as yet but little used, except for special classes of vessels. Mild steel has taken the place of iron, and effected a considerable saving of weight. Alloys of steel with nickel and other metals are now made which give strength and rigidity much superior to mild steel, in association with ample ductility. For destroyers and torpedo boats this stronger material is now largely used. It has also been adopted for certain important parts of the structures of recent ships in the Royal Navy. Of course, the stronger material is more costly, but its use enables sensible economies of weight to be made. It has been estimated, for example, that in an Atlantic liner of 20 knots average speed about 1,000 tons could be saved by using nickel steel instead of mild steel. This saving would suffice to raise the average speed more than a knot without varying the dimensions of the ship.

Alloys of aluminum have also been used for the hulls or portions of the hulls of yachts, torpedo boats and small vessels. Considerable savings in weight have thus been effected. On the other hand, these alloys have been seriously corroded when exposed to the action of sea water, and on that account are not likely to be extensively used. Other alloys will probably be found which will be free from this defect, and yet unite lightness with strength to a remarkable degree.

Other examples might be given of the fact that the metallurgist has by no means exhausted his resources, and that the shipbuilder may look to him for continued help in the struggle to reduce the weights of floating structures.

It is unnecessary to amplify what has already been said as to possible increase in the efficiency and types of propellers. With limited draught, as speeds increase and greater powers have to be utilized, multiple propellers will probably come into use. Mr. Parsons has shown how such problems may be dealt with, and other investigators have done valuable work in the same direction.

In view of what has happened and is still happening, it is practically certain that the dimensions of steamships have not yet attained a maximum.

Thanks to mechanical appliances, the largest ships built or to be built can be readily steered and worked. In this particular difficulties have diminished in recent years, notwithstanding the great growth in dimensions.

Increase in length and weight favor the better maintenance of speed at sea. The tendency, therefore, will be to even greater regularity of service than at present. Quicker passages will to some extent diminish risks, and the chances of breakdowns will be lessened if multiple propellers are used. Even now, with twin screws, the risk of total breakdown is extremely small.

Whatever may be the size and power of steamships, there must come times at sea when they must slow down and wait for better weather. But the larger and longer the vessel, the fewer will be the occasions when this precaution need be exercised.

It must never be forgotten that as ships grow in size, speed, and cost, so the responsibilities of those in charge increase. The captain of a modern steamship needs remarkable qualities to perform his multifarious duties efficiently. The chief engineer must have great powers of organization, as well as good technical knowledge, to control and utilize most advantageously the men and machinery in his charge. Apart from the ceaseless care, watchfulness, and skill of officers and men, the finest ships and most perfect machinery are of little avail. The "human factor" is often forgotten, but is all-important. Let us hope that in the future, as in the past, as responsibilities increase, so will the men be found to bear them.

A NOVEL FIRE ESCAPE.

A NOVEL FIRE ESCAPE.

WE must evidently not exaggerate the services that, in case of a fire, may be rendered by a ladder through which the inhabitants of a house must escape without the presence of anyone to support them or help them to maintain a little coolness. In fact, with many people, the danger in such a case is that they lose their head, and this renders them incapable of performing a little piece of gymnastics such as descending a ladder. Nevertheless, since a ladder may prove useful in such a case, it is well to seek a method that shall permit of leaving one of these apparatus in a position in which it may be immediately unwound through a window when necessity requires it, and, when not in use, be kept in the interior so as not to offer an easy means of ascent to burglars. Mr. Emil Robiole, an American inventor, seems to have solved the problem of a fire escape of this kind in a really practical and original manner. As may be seen from the accompanying figure, the apparatus consists of an easy chair which may be used as an article of furniture, and which is provided underneath with a windlass around which a ladder is wound by means of a winch.

This ladder, which consists of steel cable provided with rounds of the same metal, ascends through the hollow back of the chair and carries at its extremity a heavy bar of steel which, when the ladder is wound up, rests against the upper extremity of the back. In order to facilitate the sliding of the ladder over a window sill, the top of the chair is provided with two jointed arms carrying a roller. In order that the chair may have greater solidity and form a counterpoise to the loaded ladder, the bottom is provided with a heavy plate of iron. The winch may be detached and put aside when the ladder is wound up and the chair is used simply as a piece of furniture.

THE MINING AND PREPARATION OF KAOLIN.

THE kaolin which occurs in the position of the original feldspar is called residual kaolin. Frequently it happens that this residual material is carried away by the streams and deposited as sediment in a distant locality. It might then be called transported or sedimentary kaolin. The residual kaolin is likely to have considerable quantities of fragmental crystalline quartz, mica and undecomposed spar, with smaller quantities of other minerals, while the transported kaolin is likely to contain iron oxide, lime carbonate and other impurities intimately diffused through the mass. Hence of the two classes the first is likely to furnish the purest grade of kaolin, as the impurities are nearly all in coarse particles, which can be separated by washing. Although in natural condition the second is purer kaolin, such impurities as do occur are likely to be of a nature that will not wash out.

The residual kaolin deposit will take the form of the feldspar body from which it is derived, which is generally that of a vein or dike. In most cases the rocks in which kaolin deposits occur are disintegrated to a great depth; and it is difficult, sometimes impossible, from the small opening made, to determine either the kind of rock in which the kaolin occurs or the size of the deposit. The common method of removing the material adds to this difficulty.

The transported kaolins occur in sedimentary beds like other clays which have been deposited as sediment from water. These vary greatly in thickness and extent, but are generally of greater lateral extent than the residual kaolins.

The common method of mining kaolin in the United States is by means of vertical shafts 25 or 30 feet in diameter lined with small pieces of lumber about 3 inches thick, 10 or 12 inches wide and 2 feet long. The ends are cut on a bevel, so that when the pieces are laid end to end they make a many-sided polygon roughly approximating a circle. This makes an exceedingly strong wall that will resist the great pressure from the clay and at the same time can be extended to an indefinite depth and then readily removed when desirable. The walls are extended downward by building on below, and when the shaft is sunk as deep as desirable, the timbers are removed from the bottom upward and the hole filled with waste as the timbers are removed.

In some places the clay has been mined from open pits, and in a few instances in underground galleries by using heavy timbers, but in most cases where the kaolin does not have a solid rock roof, or an excessively heavy loose covering, the first method described will be found to be the most economical and safest, and it is the one most commonly used.

In nearly all cases it is necessary to wash the kaolin before using it, the object being to remove the coarse material and the foreign impurities as far as possible. While this process is carried on by different methods, they are all based on the same principle, that of flotation, in which all the material is thrown into water, and the clay particles being finer and lighter than the foreign admixtures, remain longer in suspension. Hence it is only necessary to increase the length of the troughs through which it is carried or decrease the rate of flow, or both, to get the required degree of fineness in the kaolin, and remove practically all the foreign ingredients. The law that the carrying power of water increases with the sixth power of the velocity is true conversely.

One method used at many of the Pennsylvania and Delaware kaolin washing plants is to feed the crude material with a current of water into a common log washer, consisting of a horizontal beam anywhere from 10 to 25 feet or more in length, revolving in a horizontal rectangular or semi-cylindrical trough of about twice the diameter of the beam. The beam contains numerous short arms or knives which serve to break up the lumps, stir up the material and at the same time move it slowly to the opposite end of the trough from that in which it is thrown. The current of water carrying the clay passes from the log washer into a long trough or series of troughs arranged for convenience side.

The length traversed by the current in these troughs and the rate of flow may be varied to suit the character of the material used and the grade of kaolin required. The greater part of the coarse sand and the larger particles are dropped either in the log washer or close to it and sand wheels are used to remove this and prevent the troughs from being clogged. The finer sand and the mica flakes are deposited in the long series of troughs, which are commonly about 700 feet in length. These troughs are opened and the settlings scraped out at intervals.

The kaolin carried in suspension by the water flowing through this long zigzag channel is run into large vats or settling tanks. After standing for some time the clear water is drawn off and the mud is pumped into a filter press and squeezed by hydraulic pressure. The presses consist of a series of flat frames, sometimes iron, sometimes wood, strung on a central iron pipe. Bags of heavy cloth are placed in the spaces between the frames and connected with the central pipe, which is connected with the pump.

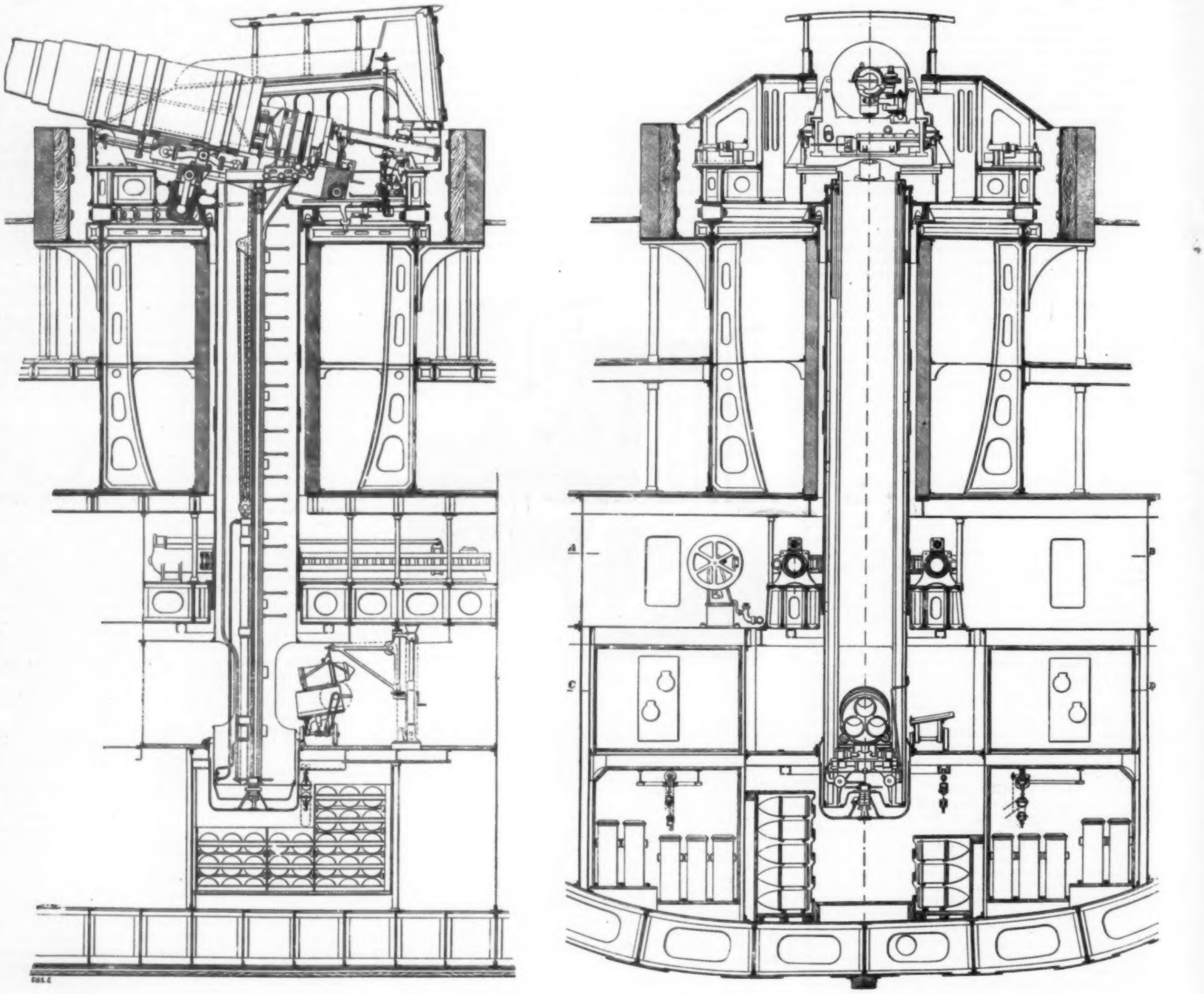
The kaolin comes from the filter press in large cakes either round or square. These are sometimes coiled in a loose roll, sometimes simply doubled over, and are further dried either by storing them in racks where they are exposed to the air for several weeks, or put on a floor or in a tunnel heated by steam or hot air.

With the cheaper grade of clays it is customary to dispense with the use of a filter press, and the clay is either dried in the settling tanks or transferred to a drying floor directly from the tanks.

Another method of washing used to some extent in this country is to put the clay into blungers instead of the log washer, where it is thoroughly disintegrated and stirred up into a slip which is run off through

troughs to settling tanks. One of the most modern plants in Pennsylvania has nine blungers, from which the material is run into 12 large cypress settling tanks, where the coarse material settles and is used for making bricks. The kaolin slip is carried thence into 10 large cypress tanks, whence it is pumped into the filter presses. The clay is removed from the press to the dry floor, heated by the exhaust steam from the engine and located close to the filter presses.

There is evidently much room for improvement in the methods of preparing kaolin for the market, as now practised in the United States. The washing plants are usually rather crude affairs, and proper attention is not always given to the different requirements for special uses and adapting the treatment to them, or closely classifying the products in marketable grades. For turning out high grade kaolin, as for the paper trade, it is usually easy to get rid of grit by elutriation and settling in the washing troughs, vats, etc., and iron can be avoided by selection of material. The chief trouble is often the presence of almost microscopic plates of mica, which are suspended in the washing process and sometimes cannot be eliminated in this way. This defect is remedied in part in one of the large Pennsylvania refining plants by passing the material through a very fine-meshed silk netting.



BARBETTE TURRET, AMMUNITION HOIST, AND MOUNTING FOR 13·386-INCH GUN FOR FRENCH IRONCLAD "MARCEAU."

The cost of mining and washing kaolin varies considerably according to the character of the deposit worked, some deposits having a heavy overburden while others have none, while some are troubled with water and others are not, etc. One concern in Pennsylvania which produces 40 tons per day, employing 65 men, mines and refines its product at a cost of $2 to $2.50 per ton of refined product, includ ing interest on capital invested. The yield of china clay from crude kaolin varies widely in different localities. Some of the larger producers in Pennsylvania and Delaware give 40 per cent. as an average, but the South Mountain clays yield a higher proportion. In any case the yield is governed to some extent by the degree of refinement required; thus, for some uses, the presence of fine silica is not objectionable, and consequently this mineral is not removed; while for other purposes it must be removed, which consequently lowers the percentage of yield.—T. C. Hopkins, in Clay Record.

AUSTRALIAN QUICKSILVER.

ALTHOUGH quicksilver has not hitherto occupied other than a minor position among the metals of New South Wales, there are indications that in the near future it will be found one of the most valuable of the numerous metallic products of the colony. The presence of native mercury, or quicksilver, in New South Wales was ascertained so far back as 1841, when the Rev. W. B. Clarke, the well known Australian geologist, received a sample from a creek on the Cudgegong River, an auriferous stream, rising in the Australian Alps, and flowing through a portion of the western goldfields of the colony. Cinnabar had previously been found in the same locality. It has also been discovered in a few other places. But although Mr. Clarke, with a view to stimulating systematic search for the metal, published a popular description of the ores of mercury, little or nothing further was done. In later years mercury, in the form of cinnabar, was found at Bingara, where there are several diamond mines, in the vicinity of the Solferino goldfields; and at Cooma, at the entrance to the New South Wales snow country, where the assays of ore yielded 25 per cent. of quicksilver. The richest deposits have, however, been discovered near Yulgilbar, in the Clarence River district, one of the most fertile and beautiful in Australia, sugar cultivation being a staple industry. Some four years ago prospecting was carried on in the hope of finding a payable quicksilver deposit, and the New South Wales Department of Mines dispatched its mineralogist, Mr. J. E. Carne, to inspect and report upon the workings, with the result that that gentleman, after a most careful examination, recommended that a portion of the government prospecting vote be devoted to assisting the prospectors in their search for the lode which was suspected to exist, and, if successful, to ascertain whether or not the deposits would eventually become payable. Since then considerable developments have been made, and six distinct shafts have been put down on three parallel lodes. Several tons of the ore from these lodes have been brought to Sydney, and quantities of it distributed among the various government departments for examination and testing purposes. The ore is expected to yield from 3 to 5 per cent. of mercury, and it has been ascertained that the spent ore contains gold and silver. The area of the ground examined by the government geologist is about 130 acres, but it is believed that with the progress of prospecting operations other lodes, more or less rich, will be found. A further examination of the locality is being made by the government geologist, and his opinion is being anxiously awaited. He has definitely ascertained the existence of three distinct parallel lodes, the first discovered in the colony, and improving as they go down. When the quicksilver mining industry is fairly established, a large population will become attracted to this part of the colony, which has been for many years a portion of an immense pastoral property, and but little known. Machinery is being erected, and a preliminary testing of about one thousand tons of ore will be made. Should the results prove satisfactory, the New South Wales quicksilver trade will become revolutionized, as the poorest assays show the ore to be richer than those of the American and Spanish mines. They will also encourage the search for other cinnabar deposits, which there is every reason for believing are more numerous and richer than generally assumed. The value of the discovery in connection with the colonial gold mining industry can hardly be over-estimated. It simply means that the work of gold production will become enormously stimulated, thereby greatly increasing the already large auriferous output of the colony.—Journal of the Society of Arts.

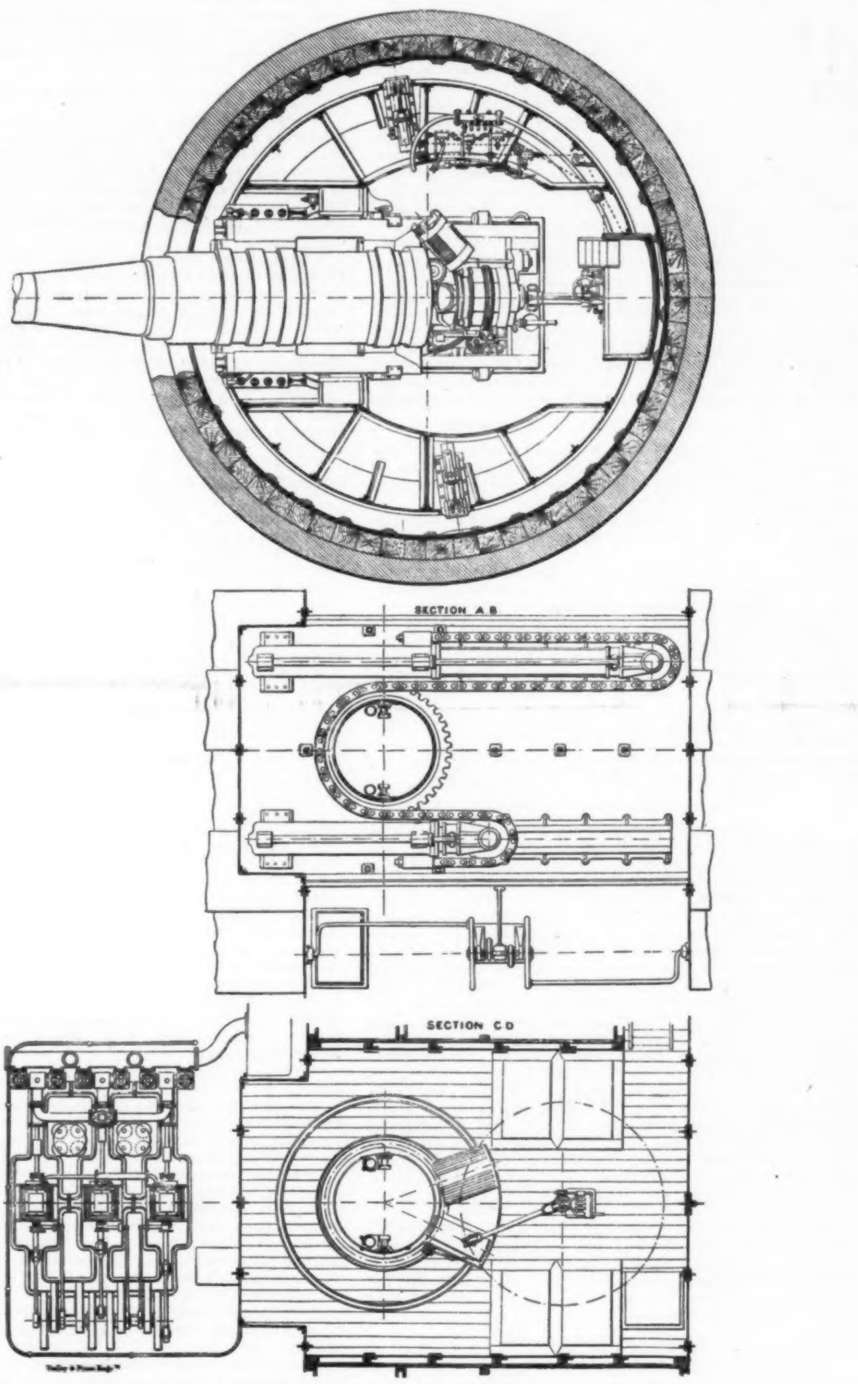
SCHNEIDER-CANET NAVAL TURRETS.

BARBETTE Turret for 340 millimeter (13·386 inch) Gun.—Turrets of this type (which we illustrate) have been built for the French battleship "Marceau"; they comprise the carriage and its slide, the turret, the elevating and lateral training mechanisms, and the hoist. The gun is invariably joined to the movable carriage, which constitutes the mounting proper, by a tongued and grooved ring which surrounds the breech-end. The carriage rests on shoes forming clamps on the slide paths of the main beams of the mounting, which consists of two vertical parallel cheeks, strongly stayed together. Recoil is governed by two hydraulic cylinders, which act at the same time as controllers in running out the gun, which can be effected at all angles by introducing water under pressure to the rear of the recoil pistons. The whole of the system rests on the movable platform, to which is fitted a vertical tube formed of plates; ammunition is supplied through this tube. It extends down to the magazines placed under the armored deck, and is guided at both ends; it is used to rotate the turret, through the hydraulic cylinders and chain on a lower deck. The distribution chest for water under pressure is placed at the level of the lower staging. The mounting and all its mechanism are completely protected by the fixed armor, and also by a light structure which turns with the platform. In the rear is the gunner's stage, surmounted by a shield.

For elevating the gun, the slide pivots round its trunnions in front, the trunnion plates being fixed to the movable platform; the latter rests, with the interposition of a ring of rollers, on the fixed circular path bolted to the upper deck. Elevation is obtained by means of a hydraulic cylinder, the piston of which, placed under the slide, causes the whole of the mount-

ing to rise or fall; a valve chest with a lever, within easy reach of the gunner, is suitably arranged for obtaining the required actions. The lateral training mechanism consists of a toothed ring fixed on the tube and surrounded on half its circumference by a plate chain. Pulleys are mounted on the ends of the piston-rods of the two hydraulic parallel cylinders, and around these pulleys the chain passes. When one of the cylinders is opened to the pressure, the other is free to the exhaust; so that when one ram is protruded, the other is withdrawn to an equal amount. Lateral training, therefore, is obtained by putting one or the other of the two cylinders in connection with the accumulator, according to the direction of rotation required. The valves are worked by a handwheel controlled by the gunner; a special mechanism operated by the same handwheel causes a continuous revolution more or less quick, one way or the other; the rotating movement stops when the handwheel is released.

For loading, the gun is elevated to its highest angle. In this position its center line corresponds to that of a hydraulic rammer, with a telescopic ram carried on



TURRET AND MOUNTING FOR FRENCH IRONCLAD "MARCEAU."

the turret platform; this rammer serves to drive home the projectile and the two half-cartridges. The charge holder is of the same form as that already described; it has three tubes mounted on an axle, placed, when in position for loading, at the same angle as the gun; a partial rotation through 120° brings the projectile and the two half-cartridges successively opposite the breech; an automatic latch-bolt fixes the barrel in the required positions. The charge holder is worked by two hydraulic pistons, the cylinders of which are placed vertically in the tube, near the guiding slides. The two plate-chains are fixed at one end to the head of the piston-rods, and at the other to the plate which supports the charge holder. The plate is also guided by two slide shoes which travel in the slides fitted to the tube. The charge holder is mounted on a truck which renders it movable in its support, and which is fitted with two rollers that travel in vertical slides; these are made to branch off at their top part. This arrangement forces the truck to travel first vertically, and when it nears the breech, to slide back so as to take up a suitable position for the loading of the gun. At the lower staging, the operations follow each other thus:

Cranes raise the projectile and half cartridges to the height of the lower deck, from where they are taken by a set of tackle that travels on a circular line made concentric with the ammunition tube. The tackle discharges in a cradle fitted to the lower part of the tube; the charges have then only to be slid in their compartments in the barrel. The gun can be loaded, whatever be the position of the firing platform.—Engineering.

REPORT OF THE CHIEF OF THE BUREAU OF ORDNANCE.*

ACCORDING to the annual report of the Chief of the Bureau of Ordnance, of the total of 989 main battery guns authorized, 756 have been completed and 751 assigned, while 13 are partially completed, and the forgings for 174 have been ordered. None of the 12-inch, 40-caliber guns are yet ready. The forgings have been ordered for the 5-inch 50-caliber guns, but none of this type are yet being made.

The new model guns have enlarged powder chambers and are of the following lengths, viz., 10 and 12-inch, 40-calibers; 8-inch, 45-calibers; 3, 4, 5, and 6-inch, 50-calibers. The first of the new 4-inch guns with its mount has been completed and tested. The gun exhibited excellent ballistic properties, a muzzle velocity of 2,991 foot seconds having been recorded within the limits of chamber pressure for which the gun was designed (viz., 17 tons per square inch), using navy smokeless powder not especially manufactured for this type of gun. It is expected that still better results will be obtained when the exact size of grain is determined for the powder. The first of the new 6-inch guns, with its mount, is nearly completed, and will soon be tested, and the first of the new 12-inch guns is assembled and in an advanced state. Two 8-inch nickel steel guns have been assembled. One of them is to be fitted with a quick-firing breech mechanism of new type, designed by Lieut. F. J. Haeseler, U. S. N., a similar mechanism fitted to a 4-inch gun having given good results. The satisfactory performance of the new 4-inch gun, which is made on the same design as regards chamber as the larger calibers, justifies the bureau in anticipating equally good results from the latter. The gun steel delivered by the manufacturers has been of excellent quality, and but very few forgings have been rejected. The process of gun manufacture is rapidly and accurately carried on at the Naval Gun Factory, due to excellent machinery, new and good mechanical devices, and to the intelligence and skill of the operatives.

The new guns will be fitted with the "Welin screw" or breech plug, which gives a proportionally larger threaded area than the plugs now in service, and therefore admits of a shorter and lighter plug, which is a matter of considerable importance, especially in the larger calibers. A new type of breech mechanism has been adopted for the 6-inch and 5-inch rapid-fire guns of 50 calibers which possesses several admirable features. It has great power to unlock, has a combination electric and percussion firing attachment, and an automatic ejection of the primer. These guns will not require brass cartridge cases.

The work on gun mounts has progressed simultaneously with the guns. The turret mounts of the four new harbor defense monitors will have the same general characteristics as those for the "Alabama" and "Maine" class, but the construction has been improved in several important details. The first mount is well under way. A new type of 6-inch mount for the 6-inch gun of 50 calibers has been designed, and is nearly completed and will soon be tested. A new type of mount for the 4-inch 50-caliber gun has been designed, manufactured, and tested with satisfactory results.

A 14-pounder (3-inch) rapid-fire gun is completed, and the mount nearly ready, and both will soon be tested. This is a new type of gun so far as the navy is concerned, and is intended for part of the armament of the new "destroyers," and probably will form an important part of the secondary battery of future battleships and large cruisers. It is designed for 3,000 foot seconds muzzle velocity, and, therefore, should have great range and a flat trajectory. Its remaining velocity at 3,000 yards should be 1,400 foot seconds, which would give it a penetrating power of 1·52 inches of Harveyized steel, or 1·22 inches of Krupp armor at that distance, rendering it a destructive weapon against the unarmored portions and exposed gun positions of an enemy's vessels.

All the new guns are being fitted for a telescope sight, and for a bar sight for day and night use, designed by Lieut. H. D. Tisdale, U. S. N., an officer on duty at the gun factory, who has also been largely instrumental in improving the pedestal mounts above referred to.

New and improved ammunition hoists have been designed and manufactured for the 8-inch turrets of the "New York" and "Indiana," and similar hoists are in an advanced state for the "Oregon," "Olympia," and "Massachusetts." Hydro-pneumatic rammers have been manufactured and installed on board the "Oregon," "Massachusetts," and "Indiana" in place of the former hydraulic rammers, which were constantly giving out, and others are now in an advanced state for the older monitors, which are now supplied with hydraulic rammers. All the later ships are to be supplied with the chain rammer, which can be operated by hand or electric power.

A new type of combination primer has been developed at the torpedo station, and promises to give excellent results. The question of a means of reducing the temperature of magazines on board ship by connecting them with the refrigerating plant is now under consideration, and preliminary steps have been taken to intrduce such a feature on the battleships now being built. Special attention is being given, in connection with the Bureau of Construction and Repair, to providing good means of ventilation for turrets, a matter that the recent war showed was most important.

Owing to the number of purchased vessels added to the navy during the recent war, the supply of reserve guns has been considerably depleted, and a further appropriation for them is asked. At the naval gun factory, at the Washington navy yard, 113 enlisted men have been under instruction and 80 at the torpedo station.

The batteries for the "Kearsarge" and "Kentucky," with their accessories, have been completed, with the exception of the 5-inch guns and top carriages, which will be completed by the time the vessels are finished. The 13-inch guns of the "Alabama" and the turret fittings have been completed. The 6 inch guns are completed and their mounts will be ready in about two months. The 13-inch guns and mounts for the "Wisconsin" are completed. The 6-inch guns are completed and their mounts will be ready in about three months. The 13-inch guns and mounts for the "Illinois" are completed. The 6-inch guns and mounts will be completed in about four months. The entire ordnance outfit for all the above vessels will be ready in advance of the completion of the ships. A battery has been completed for the training ship "Chesapeake."

All the above vessels will receive entire outfits of smokeless powder.

The guns for the battleships "Maine," "Ohio," and "Missouri" and the four harbor defense monitors are under way, and they will be completed far in advance of the vessels, as will the armament of the "Denver" class. The launching tubes for all new destroyers and torpedo boats are completed, and their batteries will be ready in time.

The main battery of the battleships "Maine," "Ohio," and "Missouri" will consist of four 12-inch guns of 40 calibers and of sixteen 6-inch rapid-fire guns of 50 calibers.

The new monitors "Arkansas," "Florida," "Wyoming," and "Connecticut" will each carry two 12-inch 40-caliber guns and four 4-inch 50-caliber guns with shields. The six cruisers of the "Denver" class will each carry ten 5-inch guns of 50 calibers.

The development of the 12-inch gun has been so great that its adoption for recent vessels, rather than the 13-inch gun on the older vessels, became a logical sequence. It has a projectile of but 850 pounds weight as against 1,100 pounds for the 13-inch gun, but the muzzle velocity will be not less than 2,800 foot seconds against 2,300 foot seconds. The muzzle energy will therefore be 46,186 foot tons as against 40,404 foot tons for the 13-inch gun; penetrating power at 3,000 yards 17·92 inches of Harveyized nickel steel armor as against 15·61 inches. The racking and battering effect will be less. The new 12-inch gun will readily perforate any

* Extract from the annual report of Rear-Admiral O'Neil.

armor afloat or likely to be put afloat, and the bureau considers it a more suitable weapon for the new battleships than a gun of larger caliber.

The 6-inch rapid-fire 50-caliber gun for the new vessels will have a muzzle velocity exceeding 2,900 foot seconds, with a muzzle energy of not less than 5,838 foot tons. At 3,000 yards they will have the power to penetrate Harveyized nickel steel armor of 5·3 inches in thickness, and they have a proving ground record of ten rounds per minute.

The new 5-inch gun for the "Denver" class and the 4-inch for the monitors will be of 50 calibers and capable of developing a muzzle velocity of 3,000 foot seconds.

There are in service a considerable number of 6-millimeter automatic Colt guns, which, in general, have given good satisfaction. When they have failed it has almost invariably been due to neglect of some necessary precaution. Great accuracy is required in filling the belts; the parts move with great rapidity and the barrel becomes very hot after a short time, rendering it difficult to adjust any derangement which may occur. The bureau has ordered a 0·30 caliber Colt automatic to handle the army cartridge, for test and experiment. A 0·30 caliber Gatling, to handle the army cartridge, has also been ordered. The bureau is of the opinion that it will be found expedient to supply each vessel with a number of automatic guns of small arm caliber, according to her class, and one hand-working gun. Under such conditions vessels will be in this respect well equipped for any service. A new type of fully automatic 3-pounder gun has been tried with promising results. Such a gun has a rate of possible fire of 70 per minute, as compared with 40 for the semi-automatic gun. It also has the advantage of having four shots in immediate readiness. This device can also be attached to the 6-pounder semi-automatic gun, and the bureau is having one so fitted for experiment.

The question of the supply of armor stands as follows: The contracts for the "Kearsarge" and "Kentucky" have been completed. Armor is now being manufactured for the battleships "Alabama," "Illinois," and "Wisconsin." There remains to be delivered for these vessels, 832 tons for the "Alabama," 1,255 tons for the "Illinois," and 394 tons for the "Wisconsin," a total of 2,481 tons. Of this amount about 1,000 tons will probably be delivered during the next six week. The armor contracts for these vessels will probably be completed by January 1, 1900, or thereabouts.

The delay in contracting for the armor for these vessels was due to the fact that Congress had limited the price.

By January, 1900, the contracts should be made for the armor for the three vessels of the "Maine" class. Such armor as can probably be procured for $400 per ton is not the best armor that can be made, and hence is not suitable for the vessels in question. The bureau urges that the matter be laid before Congress as soon as it assembles.

The question of a government armor factory should have no bearing upon the supply of armor for the "Maine," "Ohio," and "Missouri," as it would under any circumstances be impracticable to obtain it from such a source in time to complete the vessels above referred to. No detriment or inconvenience to the government or its interests has been caused by this delay; but, as previously stated, armor for the above vessels should be contracted for by January, 1900. If, after a further presentation of the case, Congress decides to adhere to the present limitation, the department will probably be obliged to procure armor similar to that heretofore and now being used, but will have the consciousness of having performed its duty in the matter and will be free from further responsibility. It is quite evident that the building of armored ships of war must soon be discontinued by this government, until the vexed questions of the source of supply and cost of armor are disposed of.

Notwithstanding the improvements, the facilities of the gun factory are inadequate to meet the pressing demands of the service, and it is imperative that further extensions and additions be made.

During the year 161 guns of various calibers have been proved. No weakness or defect has been observed in any of them, though usually subjected to pressures much higher than obtained in service. Numerous tests of armor plate for vessels now building have been made. Armor-piercing and common shell, representing numerous lots of all calibers, have been tested, with, in most instances, satisfactory results.

The bureau discontinued the purchase of brown powder as soon as the late war with Spain was over, and having a good supply on hand, which can gradually be used up for target practice, directed the powder manufacturers to give their attention entirely to the production of smokeless powder of navy standard, known as pyro-cellulose. It is most gratifying to the bureau to be able to report that thus far no unfavorable qualities have been detected in this powder when properly made. Its ballistic properties and keeping qualities appear to be excellent and to remain unimpaired even when subjected to excessive temperatures of heat and cold and to extreme degrees of moisture. No dangerous pressures are recorded, nor have any of abnormal character been observed in well made powder of this kind. The question as to the best mode of ignition is now receiving considerable attention. The bureau has decided, as a precaution to be observed for a year or two, to fix rather small charges; this not only for the purpose of observation and safety, but that the guns may not suffer unduly from erosion, though the latter thus far is almost an unknown condition, which seems to be one of the very good qualities of the navy smokeless powder, as compared with cordite and other powders containing nitroglycerin.

The uniformity of navy smokeless powder depends largely upon the rate and thoroughness of drying and upon the amount of solvent remaining in it when used. The specifications are, however, very explicit in this respect, and are fully understood by the manufacturers. The drying requires usually from four to six weeks, and where large quantities are turned out daily, the question of drying becomes a serious one, particularly so on account of the risk in case of fire, as a large amount of capital is kept in a precarious state pending the acceptance of the manufactured article. It is not unlikely that by processes other than those now followed, quicker drying can be effected.

[Continued from SUPPLEMENT, No. 1246, page 19970.]

AMERICAN RAILROADS.

THEIR RELATION TO COMMERCIAL, INDUSTRIAL AND AGRICULTURAL INTERESTS.*

DECLINE IN CANAL TRAFFIC.

THE greatest number of new boats registered as operating on the canals in a single year was in 1862, when there were 850 new boats. In the year 1897 there were only 16 new boats registered. You will wonder what has caused the abandonment of several canals in the State of New York, and the steady decline in the commerce passing through the Erie Canal.

There are three general causes for these results. The first is the great reduction in the rates of freight by the railroads in the United States, and notably in the State of New York. The second cause is the marvelous development of the motive power and rolling stock of American railways. Less than a quarter of a century ago, upon the average American railroad, the capacity of a freight car was twenty thousand pounds; the capacity of a freight engine was from twenty to thirty of such cars to the train.

To-day, on the New York Central, whose six tracks run alongside the Erie Canal for the entire distance from Buffalo to Albany, the capacity of the grain cars is from sixty to sixty-six thousand pounds, and a locomotive of the latest type will haul from seventy-five to ninety such cars loaded to their full capacity. It is not an infrequent occurrence for a single engine to haul through the Mohawk Valley, beside the Erie Canal, eighty-five to ninety thousand bushels of grain in a single train. The same engine will haul from one hundred and ten to one hundred and twenty-five empty cars. When you consider that in the busy season there are from seventy-five to one hundred such trains a day passing over the New York Central alone, you will get some conception of the situation.

EXPORT TRADE REQUIRES FAST TIME.

The third cause for the failure of the canals is the general demand of the American public for quick time. A shipper having a hundred thousand barrels of flour, or a million bushels of grain for export, must move it from Buffalo to New York within a specified time, and he cannot risk the slow process of the canal.

RAILROADS ESSENTIAL TO PROGRESS.

In a recent address before the Chamber of Commerce of Rochester, N. Y., I cited this illustration of the difference between modern railway transportation and transportation by canal:

In 1822 Thurlow Weed, one of the great newspaper men of his day, wrote of what is now the city of Rochester as follows:

"Rochester is a straggling village containing about half a hundred inhabitants, but it is a go-ahead place, and from its advantages is destined to become an important inland town."

At that time Rochester's only means of transportation was the Erie Canal, and the difference between the insignificant village of Rochester in 1822 and the magnificent city of Rochester of to-day is the difference in its transportation facilities, and this difference is graphically shown by a comparison of the canal packet towed by a mule at the rate of 4 miles an hour and the Empire State Express, thundering through the Genesee Valley at a speed of 60 miles an hour.

INFLUENCE OF RAILWAY ADVERTISING.

American railway management is always alert and ready to take advantage of every opportunity for extending the commerce of the country, and railway men are among the very first to seize upon each coign of vantage. Within a week from the day that the Paris Peace Commission adjourned, more than one American railway had ordered the re-engraving of its maps to include the West Indies, the Hawaiian Islands, and the Philippines. The description of the beauty of our American lakes and valleys, the magnificence of our rivers, the grandeur of our mountains, the fertility of our soil, the wealth of our mineral resources and the superiority of our manufactures, with which our railroad advertising is filled, has been of incalculable value to the export trade of the United States. It has induced thousands of foreigners to visit every section of our country who otherwise would never have come here. It has been the means of the investment in the United States of untold millions of foreign capital. It has been one of the strongest aids to the expansion of American commerce in every direction.

MARVELOUS INCREASE IN AMERICAN EXPORTS.

The general effect upon our export trade of the increased facilities afforded by American railways is shown in the marvelous increase in our exports, which are now the largest in our history. The increase for the eight months ending with August, 1899, being twelve million dollars.

A CENTURY OF MARVELS.

Mr. Chairman, we are approaching the end of the nineteenth century, a century which Henry Drummond said, "has added more to the sum of human learning than all the centuries that have passed."

A few examples of the achievements of American railroads in a little more than half a century, and many of them within the last twenty-five years, cannot be inappropriate.

Before the railroads were built it took a week to go from New York to Buffalo, nearly three weeks from New York to Chicago, and at that time no man would have thought of making a trip from New York to the Pacific Coast, except a few of the hardiest pioneers, and when on such an occasion the good-byes were said, it was expected on both sides that it would be forever. If to-morrow night you should place a letter on the Pacific and Oriental mail train, which leaves New York at 9:15, you may be sure that your correspondent in San Francisco will be reading it next Monday night—four days from New York.

The framers of our Constitution would have considered a man entirely beside himself who would have suggested such a possibility.

* An address by George H. Daniels, General Passenger Agent, New York Central & Hudson River Railroad, and President of the American Association of General Passenger Agents, before the International Commercial Congress, at Philadelphia, October 25, 1899.

WHAT THE RAILROADS HAVE ACCOMPLISHED.

In 1875 the States east of the Missouri River were sending food and clothing to the starving people of Kansas.

Thanks to the facilities afforded by the railroads the corn crop of Kansas this year is three hundred and forty million bushels.

It seems but a very few years since I made my first trip to Colorado, and stopped on my way at the home of Buffalo Bill, at North Platte, Nebraska, on the Union Pacific. At Ogalalla, fifty-one miles west of North Platte, the Sioux Indians were roaming over the prairies and making more or less trouble for the early settlers who ventured so far out of the beaten paths of civilization. The Nebraska corn crop this year covers eight million acres, and the yield is two hundred and ninety million bushels.

Previous to the construction of the Northern Pacific, the Great Northern, Northwestern, St. Paul, Burlington, and other railways that traverse that wonderful region known as the "wheat belt," there was nothing to be seen but prairie grass and an occasional band of untamed savages.

Minnesota this year will ship ninety million bushels of wheat, South Dakota forty-five million bushels, North Dakota sixty-five million bushels, and Montana four million bushels.

DEVELOPMENT OF THE PACIFIC COAST.

In 1849 there came across the continent reports of the discovery of gold in California, but the only means of reaching its Golden Gate was by sea around Cape Horn, or the long and perilous journey, with ox teams, across the plains, including what was then styled in our geographies the American desert, and through the hazardous mountain passes of the western part of the continent.

The completion of the Pacific railroads changed all this, and opened new fields for all kinds of enterprises in an unexplored territory stretching over more than two thousand miles to the west, northwest, and southwest of the Mississippi River, the products of which region were practically valueless until the means of transporting them were provided by the railroads.

The wheat crop of California this year is 37,000,000 bushels. The largest crop ever produced in California was in 1880, when, owing to exceptionally favorable weather conditions, that State produced 63,000,000 bushels.

The gold output of California for the year 1899 is estimated at $16,000,000.

The vineyards and orange groves of California would be of practically little value were it not for the fact that the railroads, by their trains of refrigerator and ventilated fruit cars, make it possible to transport the products of her fertile valleys to all sections of the country.

It seems but yesterday that the railroads were completed into Portland, Oregon, Tacoma and Seattle, Washington, and it is marvelous that for the year ended June 30, 1899, there was exported from the Columbia River Valley 16,000,000 bushels of wheat and from the Puget Sound region 10,000,000 bushels.

Oregon and Washington form the northwest corner of the territory of the United States, south of the line of British Columbia, and are directly on the route to our extreme northwest possession, Alaska.

The wheat crop of the States of Oregon and Washington for the year 1899 is 48,600,000 bushels.

There was exported during the year ended June 30, 1899, from the Columbia River direct to foreign ports, 1,100,000 barrels of flour, and from Puget Sound points 800,000 barrels.

Colorado, which, with its inexhaustible mines of gold, silver, lead, iron, and coal, forms almost an empire in itself, will produce this year of 1899 enormous quantities of each of these minerals in addition to a magnificent crop of wheat, fruit, and vegetables.

Thanks to her railroad facilities, Montana is to-day the richest copper region in the world.

Without railroads, Kansas, Nebraska, Minnesota, North and South Dakota, Montana, Colorado, California, Oregon, and Washington would still be the home of savages.

SERVICE OF AMERICAN RAILROADS.

It is beyond question that American railroads to-day furnish the best service in the world, at the lowest rates of fare, at the same time paying their employés very much higher wages than are paid for similar service in any other country on the globe.

In the United States the first-class passenger fares last year averaged 2·14 cents per mile, although on some large railways the average was several mills less than two cents per mile; in England the first-class fare is four cents per mile; third-class fare for vastly inferior service is two cents per mile, but only on certain parliamentary trains.

In Prussia, the fare is 2·99 cents per mile; in Austria, 3·05 cents per mile; and in France, 3·36 cents per mile.

Our passenger cars excel those of foreign countries in all that goes to make up the comfort and convenience of a journey.

Our sleeping and parlor car system is vastly superior to theirs; our baggage system is infinitely better than theirs and arranged upon a much more liberal basis. American railroads carry 150 pounds of baggage free, while the German railroads carry only 55 pounds free.

The lighting of our trains is superb, while the lighting of trains on most foreign lines is wretched.

SOME STRIKING EXAMPLES.

I may be pardoned for citing two examples of what I mean by the unsurpassed passenger train facilities of American railways.

A single locomotive recently hauled a passenger train of sixteen cars, nine of which were sleeping and parlor cars, from New York to Albany, a distance of 143 miles, in three hours and fifteen minutes, which is 44 miles per hour, and is the regular schedule time of this train. The train weighed 1,832,000 pounds, and was 1,212 feet—or nearly a quarter of a mile—long.

The Empire State Express has for years been making the run from New York to Buffalo, 440 miles, in eight hours and fifteen minutes, an average speed of 53¼ miles an hour, including four stops, two of them for changing engines, and twenty-eight slow-downs,

on account of running through incorporated towns and cities.

For one stretch of 22 miles, another of 17 miles, another of 16 miles, and another of 60 miles, the regular schedule time is exactly 60 miles an hour. For one stretch of 12 miles it is 63·40 miles an hour. For another stretch of nearly 10 miles, it is 64·86 miles an hour.

The weight of this train is 608,000 pounds, and it has seating capacity for 248 passengers.

These are some of the achievements of American railways in passenger service that have not been approached in any other country on the globe, and in my opinion it is achievements of this character that have made it possible for the United States to expand its commerce with such astounding rapidity.

The fact that American passenger service attracts the attention of people of every other country who visit our shores is demonstrated by the desire of all foreigners to ride on the Empire State Express, the fastest long distance train in the world, and the further desire to examine the magnificent machines that haul our great trains.

EXTENT OF AMERICAN COMMERCE.

The extent of our commerce, both domestic and foreign, may well astonish the representatives of other lands who visit us for the first time, but the extent of the territory of the United States, made possible by the negotiations of Admiral Dewey in May, 1898, supplemented by those of the Peace Commission at Paris, will surprise our own people, as well as our cousins from across the water.

We thought before the purchase of Alaska that our territory was large, but what vistas of commercial enterprise present themselves to us as we contemplate the fact that it is 3,144 miles from San Francisco to St. Michaels, Alaska, where an empire in extent awaits development by American capital and energy; and that it is 7,729 miles from San Francisco to Manila on the island of Luzon, and that this is only one of hundreds of rich islands that await similar development. Not overlooking the Hawaiian Islands which lie in our new ocean pathway.

Saturday afternoon last a United States cruiser left New York for Manila, via the Suez Canal, and the Sunday papers stated it would take her three months to reach her destination.

Railroad men will be interested in knowing that the Manila and Dagupan railroad on the island of Luzon, which is the principal one of our Philippine group, is laid upon mahogany ties, the road passing through forests of that valuable wood and over inexhaustible beds of coal and other rich minerals. Shall we wonder then that American railroads are seeking connections that will secure a portion of the commerce that must come from the development of this rich region, which has so recently been added to the territory of the United States?

TRADE FOLLOWS THE FLAG.

If it is true that "trade follows the flag," then with co-operation and reciprocity between the great transportation interests of the United States and the commercial and industrial interests of our republic, and with proper encouragement given to American shipping, our commerce should be as diversified as are the products of our soil, our mines and our mills; and our export trade should reach every mart on the earth, and should flourish on every sea and river where vessels ply; for, since the almost miraculous events in Manila Bay and off Santiago, we may paraphrase the sentiment of Joaquin Miller in regard to Colorado and say of our flag, "It floats forever in the sun."

COMPOUND HARMONIC VIBRATION OF A STRING.*

THIS little piece of calculation that I have on hand is a part of an investigation in which the Secretary of the Smithsonian Institution has been kind enough to aid me with some of the funds of the Hodgkins bequest, and which, stated in its broadest sense, is the study of the motion of a particle of the atmosphere under the influence of articulate speech. In some work on the use of manometric flames and the old Helmholtz resonator analysis of articulate speech, I was struck with what appeared to be the considerable variation in what we readily accept as the same vowel in pronunciation. That is, the variation in the records of the resonator analytical apparatus was apparently greater than could be justifiably ascribed to the many mechanical defects which it really possesses. In order to solve some of these difficulties, I have started upon the above investigation, and one of the problems involved in it was, of course, the behavior of a vibrating string. A great deal has been done in various ways upon the vibration of a string. Many observations have been made, for example, by photographing through a slit the successive positions of a string; that is, successive positions of a point on a string; and Prof. Robb, of Trinity College, Hartford, has made some very interesting photographs of a vibrating loose thread, developing, in some cases, a system, evidently, of compound harmonic vibration that is extremely complex and odd. You would scarcely imagine that a string would get into such positions unless you saw it actually vibrating in that way.

In order to get some sort of theoretical data to work upon, and without realizing exactly the number of figures involved, I started to compute the position of a string vibrating under the influence of the fundamental and the first seven overtones, the amplitudes of vibration being assumed proportional to their wave lengths, in order to make some sort of a rational hypothesis as to the relative intensities, taking into consideration, of course, the would-be position of the string due to any one of those components at the particular epoch under consideration. The scale upon which I started necessitated the computing of thirty-one equidistant points along the string for each epoch. Then, in order to get epochs that would take into consideration sufficiently well even the highest overtone (which was eight times the rate of the fundamental), I took as my fraction of the rate of vibration of the fundamental, $\frac{1}{64}$, so that the computation finally enumerated sixteen epochs, from the first to the sixteenth sixty-fourth of a complete period of the fundamental vibration of the string.

We have in the discussion of harmonic motions (and, under some circumstances, perfectly correctly) a way of combining them which is quite often referred to, where you simply put on the cross-section paper or draw on the blackboard a long wave and the shorter waves and still shorter waves—a set of sine curves; and then, in order to combine these, all we have to do is to take the algebraic sum of the ordinates for the ordinate of the resulting curve. That, in many cases, is all right; but in the construction of these epoch curves, of course, it is not correct, because at the instant when the fundamental is at its maximum amplitude (e. g., after one-quarter vibration), No. 2 in the series will have completed a half cycle, and, of course, under its influence the string would be straight. No. 3 is at the maximum amplitude again; but No. 4 has completed a complete cycle, and does not affect the result, and the same way with Nos. 6 and 8. Thus it becomes necessary in calculating these epochs, first, to calculate the amplitude for that particular epoch for each one of the eight components and then to calculate the thirty-one points. There is nothing to it except multiplication and addition. To obtain the result it was simply necessary to compute and plot, or compute, at least, those curves for the first quadrant, because, manifestly, the other three quadrants (that is, from seventeen to thirty-two, and thirty-two to forty-eight, and forty-eight to sixty-four) are simple repetitions of the first. They are reversed right and left or up and down, and there are really only the sixteen curves to be computed. The first curve is at an instant $\frac{1}{64}$ of the period of vibration of the fundamental after the motion begins. It is necessary to make some simplifications here, certain assumptions. In the first place, we assume that the fundamental and the overtones all vibrate in the same plane (which the string is not under obligations to do if it does not want to); in the second place, for convenience of calculation at least in this case, we assume that at the beginning of the period of the fundamental all of the overtones are also commencing one of their periods. This is probably necessarily true. Then Fig. 1 represents the

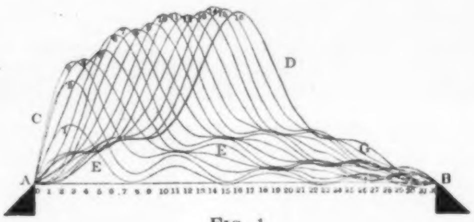


FIG. 1.

curves for the epochs $\frac{1}{64}$, $\frac{2}{64}$, $\frac{3}{64}$, $\frac{4}{64}$, $\frac{5}{64}$, $\frac{6}{64}$, $\frac{7}{64}$, $\frac{8}{64}$, $\frac{9}{64}$, $\frac{10}{64}$, $\frac{11}{64}$, $\frac{12}{64}$, $\frac{13}{64}$, $\frac{14}{64}$ and $\frac{15}{64}$, and then $\frac{16}{64}$ in the center, of course, is a symmetrical curve. In that position the string is symmetrical with reference to a perpendicular to the string at its center. Of course, the ordinates, which represent the distance of the string from its zero position, are greatly exaggerated in the figure.

There are certain things that come out, even in this quadrant, that are a little puzzling and perhaps unexpected; first, the fact that through the area between C and D (it comes out more striking when you complete the diagram with the next quadrant), a very even distribution of the string results, which, when you look at the vibrating loose string, produces a large field of apparently even-shaded surface. In the second place, we note the production of small nodal points in the area, E, F, G, where, owing to the action of the higher overtones, you get momentary nodes. The central symmetrical section is quite simple, you see, even in this exaggerated form. One reason of that is, of course, the fact that the second, fourth, sixth and eighth in the series are out of it entirely; nothing but the fundamental, third, fifth and seventh enter. The waving motion on the surface of the envelope of the curves is, of course, due to the higher overtones also. I was unfortunate enough to live down on Cape Cod, where the photographic facilities were not very great at the time I finished these calculations, and did not have time to do all I wanted to do. Manifestly, if we take a negative of that set of curves, it is only a question of printing it in the four symmetrical positions in order to get the rest of the cycle.

The partial result of such a process is given in Fig. 2,

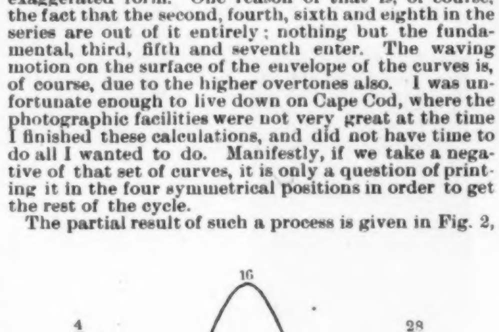


FIG. 2.

which shows the effect of printing curves Nos. 4 and 16 in the four symmetrical positions. We thus obtain the positions of the string for the epochs four, sixteen, twenty-eight, thirty-six, forty-eight and sixty sixty-fourths of the period of the fundamental. The straight line gives, of course, the position for zero, thirty-two and sixty-four sixty-fourths of the period. As to Prof. Robb's photographs (of which, unfortunately, I have not good copies at present), one characteristic is the development through the space corresponding to E, F, G of these very pronounced local nodal points, and, in a second, is the characteristic sharp rise from the point of support. I have, in Fig. 1, a set of curves from which it is perfectly evident that the same calculations enable us to plot the position of the string or the position of any point on the string with reference to time; that is, instead of taking the X along the string as the variable, if we take as the variable T (the time), we can get the curve which represents the motion of a point of the string away from its position of rest and back to that point again; and an interesting part of that is that even though the string is vibrating to this extremely—or you might almost say extremely—complex state of the fundamental and seven overtones, the motion of the string is not characterized by any sharp changes of motion. These are the characteristic curves of the motion of the string. It starts off on an easy curve and swings away; here is No. 7, Fig. 3, that is, $\frac{7}{32}$ from the left end of the string.

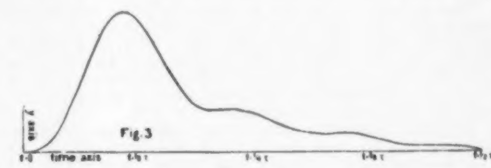


FIG. 3.

It starts up, swings up to its maximum and comes down again and goes through one-quarter of its cycle; then it goes through a series of brief vibrations to the half of its cycle, and finally winds up with a loop on the other side, at the last end of its vibration.

The formula for the above computations is: $y_1 = a$

$$\sin 2\pi\frac{t_1}{T_1}\left(\sin 2\pi\frac{x_1}{\lambda_1}\right) + b\sin 2\pi\frac{t_1}{T_2}\left(\sin 2\pi\frac{x_1}{\lambda_2}\right) + \text{etc.}$$

$$+\, h\sin 2\pi\frac{t_1}{T_8}\left(\sin 2\pi\frac{x_1}{\lambda_8}\right)$$

a, b, c to h are the amplitudes of vibration of the fundamental and seven overtones; T_1, T_2 to T_8 are their periods of vibration, and λ_1, λ_2, λ_3 to λ_8 are their wave lengths.

$a = 2b = 3c = 4d$, etc. $= 8h$. $T_1 = 2T_2 = 3T_3$, etc. $= 8T_8$. $\lambda_1 = 2\lambda_2 = 3\lambda_3$, etc. $= 8\lambda_8$.

In the computation, assuming $t_1 = \frac{1}{64}T_1$, then calculating the values of y for the successive values of x from $x_1 = \frac{1}{64}\lambda_1$ to $x_{31} = \frac{31}{64}\lambda_1$, we obtain points for the curve 1, Fig. 1.

A similar computation for $t_2 = \frac{2}{64}T_1$ gives curve 2, and so on.

I do not know that the discovery has any very wide application; but for my part, and from my point of view, it was satisfactory in pointing out that the theoretical calculation of the position of the string led to results entirely analogous to the results observed and photographed by Prof. Robb. Manifestly, it is only a question of photographing those curves—the successive positions of the string—every sixty-fourth of a second on the film of a biograph, and then mounting it complete in the ordinary form and seeing how the string is going to look actually. We can actually get then a reproduction of the theory—of the pure theory—and see how it is going to look in comparison with practice.

The loose string that I referred to is a little device that Dr. Robb got up and that has been, I think, exhibited on two or three occasions. It is simply a loose piece of white floss silk—the old apparatus for showing the formation of nodes and loops, excepting that one end is actuated like a rheotome in an induction coil, or the clapper of an electric bell; and as long as that rheotome runs comparatively slowly and the string is comparatively tight, you can readily get it so that the string will vibrate simply in one large loop or ventral segment; or, by slacking up a little bit, it will break up and give you the two segments and one complete wave; but when you go on still further, you reach a point where there does not seem to be the right rates in the rheotome to produce the higher overtones alone; and then the string gets into an extremely complex state of mind, in which it swings all along apparently without any well defined nodes at all. The only nodes visible are these little points of momentary nodes.

As to exact agreement between the experimental and theoretical curves, we never expected to get anything more than a sufficient analogy. Some of this work was provoked not so much by the physical side of the thing as by the fact that many of us are able to accept the possibilities of a vibrating string without seeing the results; but, on the other hand, there are very many—particularly outside of the domain of scientific people—for whom it is almost inconceivable that a string can vibrate at a half dozen different rates at the same time. They consider it almost impossible, and the idea seems to be that it would result in such a very complex motion of the string that it is out of the question; whereas, even this case gives rise to such easy and simple motions of the string that they are, I think, quite probable.

* A paper read by Prof. William Hallock, of Columbia University, New York, August 22, 1899, at the Ohio State University, Columbus, O., before the Section on Physics of the American Association for the Advancement of Science. Revised by the author especially for the SCIENTIFIC AMERICAN SUPPLEMENT.

Count Cassini, the Russian ambassador to this country, has returned to this country from China via the overland route. Speaking of his observations while in China, Count Cassini said: "Business men who have not been in China can hardly dream of the progress the Celestial Empire is making. It seems to have arisen out of a long sleep. Cotton mills are literally springing out of the ground, and I predict that China will have to be reckoned with as a competitor in the world's markets for cotton goods at no far distant date." The new ambassador expresses the belief that Russia will, when opened for commerce,

prove a most enticing field for the development of American foreign trade. "In Russia proper I am also glad," he says, "to know that American machinery is being adopted, and I am pleased to hear that a movement is on foot for the purpose of removing the American exhibits at the Paris Exposition to St. Petersburg and Moscow after the French exposition closes." Count Cassini was careful to correct an impression that Russia was keeping secret the facts regarding the progress of the Trans-Siberian Railway. He said the reverse was the truth, and the Czar was especially anxious to have the world fully informed as to the progress of the work.

THE MANUFACTURE OF SODIUM NITRITE.*

DETAILS of the manufacture of nitrite of soda are very scarce in chemical literature; it will therefore be of interest to briefly describe the production of this substance, which is now very widely used in the dyeing industry. The raw material used in its manufacture consists of purified Chile saltpeter, and although the presence of sodic chloride may interfere with the value of the nitrite, the re-crystallization of commercial saltpeter, with a view to the elimination of the sodic chloride, is not practised, as the expenses connected with the operation would be too great.

The saltpeter is melted in large cast-iron vessels, an operation which includes the evaporation of the hygroscopic water, and the decomposition of a part of the iodides and iodates which accompany the saltpeter. At 310° C. saltpeter begins to fuse, and before adding the lead necessary for its decomposition, the temperature is raised to about 400°-420°.

The lead should be as pure as possible, as the presence of small quantities of other metals might cause the decrepitation of the whole charge; it is antimony which is the most to be feared. The lead used must be in thin sheets. About 280 parts of lead are necessary for 100 parts of saltpeter. As soon as the melted saltpeter has reached the desired temperature, the necessary quantity of lead is gradually added; at the same time the whole must be kept constantly stirred, so as to obtain a very intimate mixture. It is necessary to carefully watch, that the charge does not become too strongly heated, for fear the vessel might be pierced; in case of emergency, to prevent such an accident, a quantity of cold saltpeter must be added, or the fire withdrawn. When all the lead has been added, the stirring must still be kept up for some time, and the melted mass is then removed by means of a large cast iron ladle. It is then run in the form of fine threads into cold water, in which its solution is helped by constant stirring. The decomposition of the saltpeter by the lead at 420°-500° has the effect of producing, besides the nitrite, about 1 per cent. of caustic soda, which dissolves a certain quantity of the oxide of lead formed; this latter should also be removed. This is generally effected by neutralizing with nitric acid; in this manner saltpeter is re-formed, while the oxide of lead is precipitated in the state of insoluble hydroxide. We may also use nitrate of lead or sulphuric acid for neutralizing the solution; sulphuric acid is preferable on account of its low price, but we then obtain sulphate of soda, which is deposited in the concentrating vessels in the form of anhydrous salt. We thus have in aqueous solution nitrite, undecomposed saltpeter, caustic soda holding oxide of lead in solution, and the soluble impurities of the saltpeter, such as chloride of sodium, etc. The insoluble residue consists of oxide of lead, a very small quantity of metallic lead, which has escaped oxidation, and a certain proportion of peroxide of lead. The solution diluted to about 6°-8° Baumé is neutralized with nitric acid (or dilute sulphuric acid), or again with a solution of nitrate of lead; the oxide of lead in solution is precipitated, and the addition of the acid is continued as long as a precipitate is formed.

We may here correct an error which has slipped into most treatises on chemistry; many authors state that nitrite of sodium has an alkaline reaction, but this is not the case—the pure nitrite is absolutely neutral.

The neutralized solution separated from the insoluble residue by any convenient method is concentrated in cast iron basins until it reaches 42°-45° Baumé when warm.

The insoluble residue is thrown on a large filter of coarse material, such as sacking, washed with warm water, and the wash waters added to the principal solution. The residuary oxide of lead is capable of various applications, which will be dealt with directly. The concentrated solutions are added together in cast iron vats and left to crystallize; if the crystals thus obtained are not pure, they must be redissolved and recrystallized. The pure crystals are separated in a centrifugal machine, washed, dried, and packed.

The desiccation takes place in an oven, the temperature of which is carried to about 50°, and the crystals are packed in cylinders of double thicknesses of parchment paper.

The residuary oxide of lead may be either melted and cast as it is reduced to the metallic state, or transformed into minium; it can also be used for the preparation of white lead, of nitrate, acetate, or other plumbic compounds.

The analysis of the nitrite is generally made with a titrated solution of permanganate of potassium. By dissolving 9,594 grammes of permanganate in 1 liter of water we obtain a solution, each c.c. of which is equal to 1 centigramme of nitrite of sodium.

The analysis is carried out in the following manner: A known quantity of the nitrite is rapidly weighed and dissolved in an Erlenmeyer flask of 150-200 c.c. capacity with about 80 c.c. of water. To this solution are added a few c.c. of dilute sulphuric acid (1:4), and it is then titrated. When the coloration begins to disappear with difficulty, a fresh quantity of sulphuric acid, much stronger than the last, is added, as there is now no longer any danger of nitrous acid escaping. The addition of the permanganate is continued drop by drop until the rose tint is permanent for about a quarter of an hour.

To hasten the final reaction, the solution may be heated toward the end of the operation to 30°-40°. The analysis of the melted mass is carried out in the same manner as is that of the oxide of lead to see if the washing was thoroughly done.

* Abstract of article in the Chemiker Zeitung, by The Engineering and Mining Journal.

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